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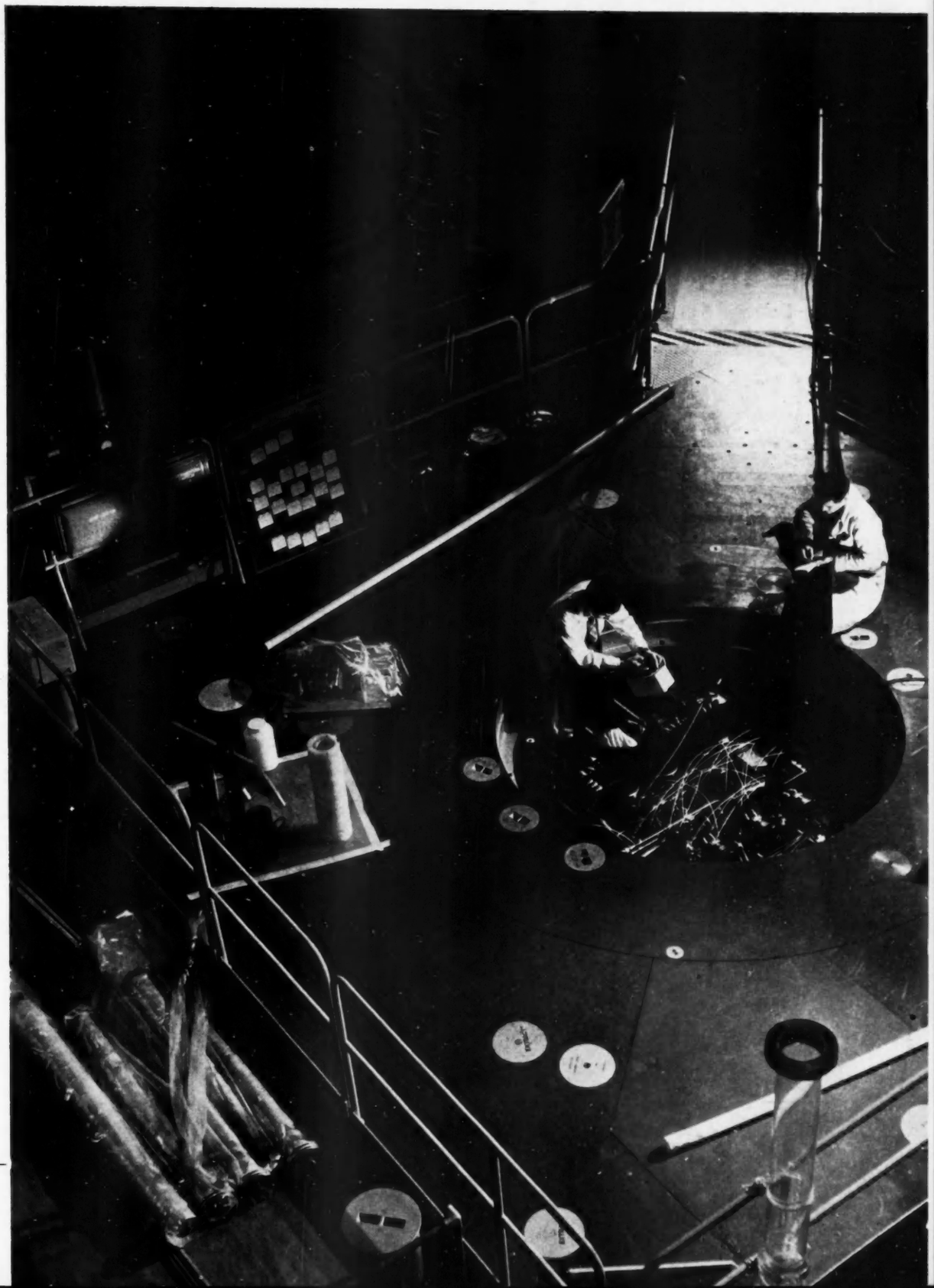

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At Sixes and Sevens

FOR some time now the European numbers game has been developing on new lines. This diversion is the gambit of the Seven or Little Free Trade Area. Those taking part are the Scandinavians, Switzerland, Austria, Portugal and ourselves. The trouble with the numbers game is that it makes complicated problems seem just a bit too easy. A seven country tie-up should on paper be a rival to a six country scheme. But whereas the Six have 184 million people the Seven have only 88 million, of whom over 50 million live in the United Kingdom.

One of the big weaknesses of the Seven is that Britain is bigger than the rest of them put together in every way. Of the others, only Sweden has any considerable foreign trade, and its total exports at $178·4 million are worth just about $600 million less than Britain's. Another snag is that agriculture is likely to be just as much of a problem to the Little Free Trade Area as it was to the big one. Denmark is certain to demand special treatment for its farmers, and several of the others will not be far behind. Portugal, a recent comer to the group, has the highest tariffs of the lot and the government, in fact, relies on these for revenue. Britain's tariffs are comparatively high in this company, averaging about 22½ per cent, which is the same as Austria's. The Norwegian average is about 17 per cent, Sweden's about 10 per cent, Switzerland's between 5 and 6 per cent, and Denmark's around 5 per cent. However the Seven set about reducing their tariffs, Britain's clearly has further to fall than most of the others. Some quotas would come off, thereby introducing new competition here. The Swedish Volvo would appear on British roads. Apart from getting rid of the quota restriction the Volvo would benefit from a lower tariff and lower total of purchase tax, which is calculated on price plus import duty. Imports of Swedish ball bearings and special alloy steels and Swiss machine tools would also go up. Other goods coming in would include scientific instruments, optical goods, toys, cutlery and glassware.

Britain's exports to the Seven would certainly rise above the present figure of £951 million. But forecasts of annual increases of £200 million in our exports are just wishful thinking. For one thing, each of the Seven, including Britain, has long established trading contacts. The fact that the Austrian or Portuguese tariff has fallen by some small amount in our favour will not send the nations of these countries on a buying spree for British cars or washing machines. They will go on buying from the agent who gives the best service. Common language will help German firms get over the tariff problem in Switzerland and Austria. On the other hand, English is still a useful talking point in Scandinavia.

So far German iron and steel and other metals, machinery, cars and chemicals have all done well in the Seven. In fact, 27 per cent of German exports have gone there compared with 29 per cent to the Common Market Six. Though Britain should make some gains on all these products, it is a mistake to overestimate what can be done.

As far as trade is concerned, this Little Free Trade Area is not going to set the Baltic on fire. Politically also it is so much of a mixture that it is likely to raise as many problems as it solves. The United Kingdom, Norway, Denmark and Portugal are all NATO members. Switzerland, Sweden and Austria are all neutrals. The only organisation the Seven have in common is OEEC which for the last two years handled the abortive Free Trade Area negotiations.

However, the picture is not all darkness. There is a sense in which any move towards freer trade and bigger markets is better than none. One of the main threats seen so far in the Common Market is the way in which it has acted as a magnet for American capital. The setting up of a Little Free Trade Area might check this movement in that some firms would decide that it might be as well to have a foot in both camps.

The big hope behind it would be that the diversion of trade from Germany to Britain and the rest would cause the Germans to put pressure on the French to relent about the big Free Trade Area. So far both French and Germans have remained unexcited.

The final agreement in favour of the Seven idea—and this is another gambit in the numbers game—is that it is easier for two blocs to negotiate with each other than for 13 separate countries to do so. This may be. But it could just as easily happen that setting up a Little Free Trade Area would lead to a relaxation in the efforts to restart negotiations for the bigger unit. And what is more dangerous is that it may divide Europe into two blocs that will not negotiate with each other because each sees the other as its rival. All things considered then, the Seven or the Little Free Trade Area, or whatever it called, can be only a second best affair.

We regret to state that because of the current dispute in the printing industry, which is affecting British periodical publishers, future issues of Engineering may be reduced in size or publication may be suspended temporarily.

Cover Picture.—*The top of* PLUTO *with the drop shield removed. The area is being checked with a portable health monitor. Visible in the photograph are the tops of two safety rod housings (square section, black), the fine control rod housing (small black cylinder) and the seven coarse control arm housings, four on the far side and three on the near side. The tops of some of the 26 fuel elements can also be seen within the chamber.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

Riding down Fifth Avenue in the back of an open tourer are two small figures. Bewildered by the cacophony of unsynchronised brass bands, harassed by ticker tape and streamers, embarrassed by shapely girls in boots and gauntlets tossing maces in the air, deafened by cheering crowds, the two small heroines cower in their seats. They cower, not fully aware of the new dignity they have achieved. If they listened carefully they might detect in the cheering a note of envy, even of malice.

Like most other sensitive people, I heard with mixed feelings the news that a rocket, launched from Cape Canaveral, had carried two live monkeys to an altitude of 300 miles and that the monkeys had been recovered unharmed from the South Atlantic.

The two monkeys were small and female. They were, I gather, rhesus monkeys, which are very similar physiologically to man and the results of constant instrument examination suggest that no ill effects would be suffered by a human occupant.

The monkeys wore space suits. The biggest—unromantically called Able—weighed 7 lb and lay on her back on a glass fibre couch with her knees drawn up to ease the pressures on her body when the rocket accelerated. Her chamber had its own air conditioning and heating systems. She wore earphones and had a telegraph key she had been trained to press in response to a red signal. This she did not do, for reasons unexplained; perhaps because of a female contrariness, or more probably because animals, like humans, don't like being pushed around. Her companion, Baker, weighed only 1 lb and was differently housed and equipped. Perhaps, as the League Against Cruel Sports and the Conference of Anti-Vivisection Societies have demanded, the next occupant will be a man—and a volunteer.

"Let man pull his own chestnuts out of the fire," Able says to Baker. I picture her as something between Madame de Staël and Bessie Bunter. To tell the truth, since Darwin demonstrated our common ancestry, we have tended to be rather down on monkeys. Dogs projected into the troposphere precipitate our patronising warmth and charity. Monkeys, on the other hand, like unacknowledged relatives from across the tracks, are too close to us and have to be treated as figures of fun—or abuse. Cats, to take another creature as illustration, are nice to kittens but beware of other cats. Meanwhile, Able and Baker, our second cousins twice removed, will be stealing a march on us, colonising Venus; while we're still playing Cain and Abel here below.

CAPRICORN

Weekly Survey

World Money Wins the Day

The world recession of 1958 is now at an end, apart from the after effects. For some countries these consequences may still be painful but for most production is rising and unemployment falling. Two countries in particular are worried lest the boom which is now beginning to develop goes too far. The United States is still losing its gold reserves at a significant rate due mainly to its persistent position as a high-cost producer. Its exports are consequently slow to sell, while the rising purchasing power of its home market offers continuing good export prospects to the countries of Western Europe, notably for motor cars. In Germany there is also concern lest costs and prices get out of hand and the recent level of share prices in Germany has raised once again the spectre of "inflation," a word with a high emotional impact in that country.

Last year's recession (it actually started in 1957) was sharp but short-lived. The great worry while it lasted was that the checks and balances which could be used to control it might not be strong enough and that the primary producing countries in particular might catch the recession from more industrialised areas and add a particularly powerful depression virus of their own. In the event, such countries were able to maintain their importing capacity to a remarkably high degree and it is now clear that this was possible because of the high level of international investment. The part played in combating the recent recession by the various international organisations set up since the war to stimulate overseas investment has given them a new kudos.

This increased prestige is likely to spill over into other international organisations. The proposal to augment the resources of the International Monetary Fund last year was particularly popular in this country. In the last 12 months the holding of monetary gold has shifted significantly. The United States in particular has lost large quantities, but the Germans too have reduced their attractive power for gold by increasing their foreign lending. The scheme to raise the IMF's gold resources might therefore have become somewhat less attractive to the wealthier member countries but the recent record of the World Bank and other international lending organisations has underlined the advantages of international cooperation in maintaining economic stability.

Research Protesting

The annual delegate conference of the Institution of Professional Civil Servants heard some caustic comments on research priorities and Civil Service negotiating mechinery from Mr. Stanley Mayne, the general secretary. His address to the delegates dealt mainly with three points: priorities in research expenditure, efficiency of communication between management and technical workers in the Civil Service and the sins of the Treasury in salary negotiations.

The first two of these are of interest beyond the ranks of a delegate conference. At a time when the scope for research, judged on technical grounds, is expanding more rapidly than the financial resources available, the problem of pruning becomes grave and urgent. In the course of pruning, promotion opportunities and even jobs become affected. The question is to what extent sectional interests, inside or outside the Civil Service, can be allowed to affect the rate of technical progress. But it is reasonable to expect that when Government research projects are due for the axe every opportunity should be taken to hive them off to commercial organisations and their research organisations. Mr. Mayne cast doubt last week on whether everything that might be done in this direction had in fact been tried.

His attacks on certain nationalised industries, including the Atomic Energy Authority, on lack of communication between top management and specialists raises a point of great importance. There have been complaints before that organisational decisions have been taken in nationalised industries and Government departments responsible for applied research without drawing sufficiently upon the knowledge and experience of technical people. It may be due to some extent to the rigid classification in the Civil Service between administrative and technical work. This division can at times be taken too far and on occasions it is based upon erroneous premises, namely, that good management is an art or science in itself which can be entirely divorced from technical issues. This is an assumption which engineers and other qualified people are likely to resist.

British Role in Europe?

In the second occasional paper published by Political and Economic Planning as part of its three-year study of the European Market, Mrs. Miriam Camps summarises the history of the free trade area negotiations and puts forward some of the implications for future negotiations. The author suggests that one of the main reasons for the failure of the negotiations was a fundamental miscalculation by the British Government in the autumn of 1955 about the strength of the movement toward greater unity among the six Common Market countries. A further factor was, of course, the difficulty of negotiating in the absence of a statement of the French views and even for a time of a French Government. Although the British White Paper of February, 1957, marked the end of 25 years of protectionism and advocated trading arrangements that made minimum concessions to special interests, it appeared to Continental countries to lack political purpose and to be designed to acquire the maximum commercial gains for the least possible cost.

As regards the future, the first requisite is seen to be a satisfactory definition by the British Government of what this country's role in Europe should be. The author suggests that it may be advantageous to defer negotiations on a long-term arrangement for a few years. This would give an opportunity for the Common Market to become more cohesive and would enable a view to be taken as to whether the Community will prosper or whether it has lost the support of Governments that is indispensable to its success. It might also be hoped that it would provide an opportunity to allay suspicions that the United Kingdom wishes to break up the Common Market, while the increased effects of external competition from the other Common Market countries may produce a change in the attitude of France towards participation in the wider market.

West Europe

The ECE Economic Survey of Europe in 1958 gives an encouraging account of the possibilities of renewed industrial expansion in Western Europe. Apprehension about the effects of the American recession had given way by the end of the year to a mild optimism. Business activity was on the upturn everywhere with the possible exception of France.

Four recent developments are cited as evidence of the halting of the recession in the United

Kingdom. First, industrial production had revived by the end of 1958; second, the trend of exports improved after the third quarter which indicated that the running down of stocks of imported materials had ended; third, bank advances went up rapidly between August and November against the normal seasonal trend; lastly, more companies reported increased orders for the first time in over a year.

The report anticipates no great changes in the direction of trade between West European countries over the next year. The tariff and quota advantages benefitting the Common Market countries are not yet likely to exert any significant influence. Later on, however, discrimination may bring about some shifts in trade, unless some sort of association between the Six and the rest of the OEEC countries is arranged.

Britain and Western Germany are stated to have a dominant role to play in the economic revival of Western Europe. Between them these two countries absorb 25 per cent of intra-European imports and one-sixth of world trade. Policies of expansion carried out by the two together "could not fail to influence" the economic development of Western Europe. Continuous and close cooperation between the monetary authorities in London and the Six will be needed, says the report, if "continuous and balanced growth" is to be achieved.

The report doubts whether the new payments machinery will be sufficiently flexible to enable it to be used to correct upsets in the balance of international payments. This doubt will only be justified if member governments are unwilling to vary exchange rates when the need arises. All told, therefore, the EEC report sees a break in the clouds but not a clear blue sky.

East Europe

For some years the best source of information on the economic situation in the Eastern European countries has been the annual Economic Survey of Europe prepared by the secretariat of the Economic Commission for Europe (ECE). This year the section on Eastern Europe contains, for the first time, thumbnail sketches of the industrial situation in each of the satellites. For the area as a whole the biggest problems are the raising of productivity and the elimination of the worst shortages.

In Czechoslovakia, Hungary and Poland consumption a head was formerly low because of investment drives and defence expenditure. The gradual relaxation of spending on these items produced higher living standards in the two years up to the end of 1958. In Czechoslovakia the gross output of fuel and energy rose last year for the first time since 1954. Metal shortages did not, as in 1957, hold up investment in machinery or engineering exports. At the same time higher productivity has eased the Czech labour shortage. The big unsolved problem is to avoid building up the large unsaleable surpluses of particular goods which highlighted the shortages of others.

The East German economy is much weaker than the Czech because of its dependence on imported fuel and raw materials. Output of electric power and the installation of new machinery have both gone up for the first time, but planning is hampered by shortage of raw materials and labour. Hungary, thanks to credits granted by the USSR in 1957, enjoyed a measure of economic recovery. The main raw materials are bauxite and ores of nuclear fuels. In 1958 industrial output and exports of machinery both went up. In Poland, in contrast to the difficulties of earlier years, industry prospered largely because it was possible to draw on stocks of raw materials. There was greater expansion in engineering and chemicals than in other sectors.

Information on Romania is not so complete as for the other East European states. It appears, however, that there has been a concentration on basic industries, notably oil and natural gas. The completion of the Hunedoara blooming mill at the end of last year is expected to lead to considerably increased output. Engineering plays only a very small part in the Bulgarian economy, the main emphasis being on textiles and agriculture. Efforts are now being made to increase output in chemicals and the metal using industries. Albania, perhaps because it started from farthest back, put up the best performance in hitting industrial targets. The new oil refinery at Cerrik produced large quantities of motor spirit and diesel. These states are now reaching the point where rigid plans are no longer satisfactory. Rising real incomes and a taste of freedom for the consumer need a system with rather more give and take in it. This will involve decentralisation of distribution, increased local control over production and incentives for the workers. It remains to be seen whether these can be provided.

Euratom Powers

The second general report of Euratom, which covers the six months to the end of March, estimates that the "first generation" of nuclear power stations in the six Euratom countries will have a total power capacity of 4,000 MW. This figure may prove to be over conservative. The report underlines the importance which the Euratom Commission attaches to the rapid establishment of a Community Research Centre. It has decided that a completely new centre would take too long to construct and is considering whether some of those already in existence might be put, wholly or in part at its disposal. A programme of research is being carried out on heavy-water reactors, including the construction by the Commission of a prototype reactor.

Various outside bodies are to carry out research work for the Commission. The first contracts for this will be issued shortly. They will deal with radiobiology, plutonium and controlled nuclear fusion. Negotiations for a common programme on the latter subject are in progress with the French Atomic Energy Commission and also the Max Planck Institute at Munich. The biggest item mentioned in the report is the Dragon project for the construction and study of a high-temperature gas-cooled research reactor at Winfrith Heath, the cost of which is being borne jointly by Euratom, the United Kingdom, and several other European countries.

Portfolios of European Trusts

In the first three months of the year four big investment trusts were set up in the European Common Market (Weekly Survey, 20 March). These are Europa I, Eurunion, Europa-Chemie and Europa-Valor. Europa I, launched by the relatively small private banking firm of Hardy and Company, of Frankfurt and Berlin, got a head start of the others. Although most of the 300,000 certificates sold by the end of March went to nations of the Six, many found purchasers in countries abroad, including Britain and the United States. Its portfolio contains a nice mixture of nationalities and industries. At present it holds few shares in French concerns, and hearly half its securities are German. Among Europa's engineering interests are Philips Lamps (Holland), Siemens and Halske, AEG and Demag (Germany), Citröen, Peugeot and Michelin (France), Fiat, Societa Edison and Pirelli (Italy), most of the German steel works, and Arbed of Luxembourg.

Eurunion, which was sponsored by a consortium of banks under the name Europa-Syndikat of Luxembourg, has the shares of about 50 different firms in its portfolio. Eurunion's securities include Mannesmann and Hoesch-Werke in iron and steel, four big banks including Dresdner Bank and Deutsche Bank, cement, transport undertakings, rubber, tyres, paper, motor cars, textiles and oil. Chemical shares make up about a fifth of the holdings. The third unit trust, Europa-Chemie, launched by Gesellschaft für Internationale anlageverwaltung of Basle, does not confine itself to the Common Market. It has a portfolio of 84 chemical companies spread over the OEEC countries. German and Swiss shares account for 20 per cent each and Belgium, France, Italy, Holland and Britain have 10 per cent each. The Europa-Valor trust is also Swiss, its sponsors being the Société des Placements Internationales of Basle. It holds shares in 31 concerns in the six common market countries, plus shares in four British companies. These are Distillers, Imperial Chemicals, Prudential Insurance, and Shell Transport and Trading Company. Between them the four trusts present a new and, to judge by results, highly popular form of investment.

Able Baker Over

The little dog will be laughing on the other side of his face now, even if Able and Baker did not quite jump over the moon. No offence to Laika, whose successor probably will. The achievement of the two monkeys launched in a rocket from Cape Canaveral to a height of 300 miles and recovered apparently unharmed seems to have demonstrated man's (or at least protoman's) ability to travel in space. The fact that the two monkeys were small and female would not invalidate the application of the findings to the much larger male who will probably be the first space traveller.

Telemetry devices, relayed to earth information on the monkeys' condition—heartbeats, muscular reaction, pulse timing, body temperature and rate of breathing. Scientists were particularly concerned with the effect on the monkeys of the noise of the rocket, of the acceleration when it took off and the deceleration when the nose-cone re-entered the atmosphere and was slowed by parachutes, the effect of vibration, rotation and weightlessness. Environmental conditions, such as temperature, pressure and humidity inside the capsules in which the monkeys were strapped, were also registered.

The rocket in which the monkeys were housed was a Jupiter missile, which reached a top speed of 10,000 m.p.h. and travelled for 15 minutes. It landed within 10 miles of the recovery ship in the target area. The two monkeys—Able turning the scale at 7 lb and Baker a mere 1 lb in weight—wore space suits. It is reported that both monkeys were very angry when they got down.

Letters to the Editor

INSIGNIA AWARD IN TECHNOLOGY

SIR, Thank you for the reference to our Special Insignia Awards in Technology published in The Human Element in ENGINEERING of 10 April. These Special Insignia Awards are limited to five a year, namely one for each of the main branches of industry, but our normal Awards in Technology can be earned by an unlimited number of candidates.

The Insignia Award in Technology was established by the Council of the Institute in 1952 to help to meet the national need for technologists qualified to occupy positions of special responsibility. A booklet giving details of the award with notes for the guidance of candidates may be obtained free from the Director (I.A.), City and Guilds of London Institute, 76 Portland Place, London, W1.

Yours faithfully,
L. M. ANGUS-BUTTERWORTH,
Secretary to the
Insignia Award Committee.

City and Guilds of London Institute,
76 Portland Place, London, W1.
25 May, 1959.

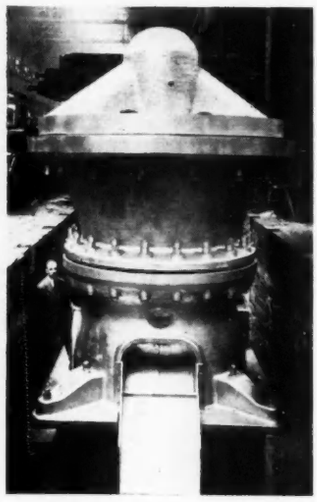
GYRATORY CRUSHERS

Roller Bearings Throughout

THE Babbitless range of gyratory crushers employs roller bearings throughout. There are two types, primary and secondary or fine.

Primary crushers are made in 15 models having throughputs varying from 6 to 5,500 tons per hour and crushing to sizes from $\frac{3}{8}$ in to 10 in. There are seven models of secondary crushers having size ranges from $\frac{3}{16}$ in to 2 in, and throughputs from 3 to 330 tons per hour. Most of the models (both primary and secondary) offer a choice of fineness sizes. The capacities quoted are for tough rocks weighing 100 lb per cu. ft.

This type of machine is mainly used for crushing fairly dry materials such as ores or slag and is claimed to require very little maintenance or lubrication. High rotational speeds are possible giving high output for a given size of machine. No cooling system for the lubricant is necessary. The mechanism is claimed to be both dust and water proof.



Babbitless Company (Great Britain) Limited, 123 Victoria Street, London, SW1.

MOBILE COMPRESSOR

Diesel Driven Air Cooled Model

THE Jenbach diesel driven mobile air compressor is now available in an air cooled version.

Air cooling offers several advantages over water cooling in mobile plant, particularly when used on contractors' sites where clean water is not easily come by.

This version has a capacity of 78 cu. ft per minute at pressures up to 100 lb per sq. in. There is a $3\frac{1}{2}$ cu. ft air receiver mounted on the frame, and two $\frac{3}{4}$ in hose connections are fitted. Pressure regulation is automatic by means of a valve in the induction pipe of the compressor, operated by a pressure dependent cutout governor.

The prime mover and the compressor form a single unit. The single cylinder works on the four stroke cycle and its power is transmitted directly from the crankshaft to the compressor piston by an aircraft type secondary connecting rod linked to the main connecting rod.

The engine and compressor cylinders are at 90° whereby the inertia forces are balanced, giving smoother running. This is also helped by the two heavy flywheels mounted one on each side of the engine.

Starting is by an electric motor with dynamo and battery. A speed variation governor operated by a single lever gives a speed range between 1,000 and 1,500 r.p.m. to allow for particular requirements. Cooling is supplied by a high efficiency blower for the engine and compressor cylinders, and a separate fan for the compressed air cooler. *Chamberlain Plant Limited, Crown Works, Southbury Road, Enfield, Middlesex.*

TRUCK CRANE

Boom Extends to 100 ft

THE MEI truck crane has been introduced to meet the American 25 short ton rating at 10 ft radius.

On British ratings the crane will lift $22\frac{1}{2}$ tons (50,000 lb) at 10 ft radius when working with the standard 30 ft boom. The truck on which the crane is mounted is a six wheeled Foden chassis powered by a Gardner 5LW engine developing 94 b.h.p. at 1,700 r.p.m. Alternatively, a 6LW engine can be fitted. The carrier incorporates outriggers with screw jacks which can be extended to 13 ft to steady heavy loads and high lifts. The tyres are Michelin D20 metallic corded Y type.

Power for the crane is supplied by a second 5LW engine. The boom can be extended by the addition of 10 or 20 ft lengths to its maximum of 100 ft. The boom head is semihammer construction which simplifies reeving and improves the clearance between the boom and the load. A tubular fly jib is available as an alternative. *Thomas Smith and Sons (Rodley) Limited, Rodley, Leeds.*

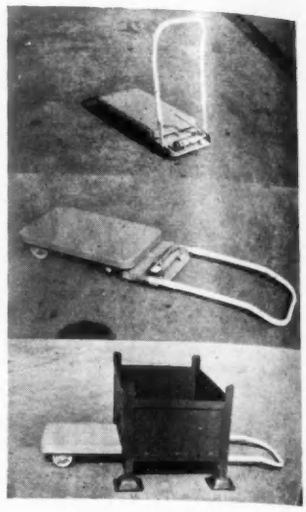
LIFT TRUCK

For Handling Stillages or Pallets

PARTICULAR claims for the Flattie medium duty lift truck are that it can handle stillages in a straight line, as it will pass under them.

After the first stillage has been unloaded from a lorry by a fork truck the Flattie can draw the next one forward and then be lowered to pass under it leaving the way clear for the fork truck to pick it up without any additional manoeuvering. Similarly in narrow gangways a row of stillages can be brought forward one at a time, the Flattie passing under each in turn.

The truck is steered by a castor and the effort to move a stillage is greatly reduced if the direction of trail of the castor is set before the load is lifted. The lifting pump can be operated by hand from road level or by foot from lorry level and there is a variable speed release control. The maximum capacity is 20 cwt and the platform measures 18 in wide and 30 in long. A model 36 in long is available for use with 54 in stillages. There are also two lowered heights, 3 in or 6 in. *Eccles (Birmingham) Limited, Mechanical Handling Division, off Arrow Road, Redditch.*



ELECTRIC TYPEWRITER

Quieter Smoother Operation

SEVERAL improvements are claimed for the new IBM electric typewriter, aimed at reducing fatigue.

First is a quiet glide carriage which has been fitted with a decelerator action for cushioning both tabulation and carriage return movements giving an appreciable reduction in noise and vibration. Second a degree of buoyancy has been given to the key movement indicating the precise point at which the work bar is actuated and therefore the end of the useful stroke. The keyboard has been reduced in slope to enable speed of operation to be improved and a more uniform touch for all letters. An adjustable touch control allows the typist to choose the feel preferred and also helps in the change from a manual to an electric machine. The tripping point of the space bar can be adjusted to individual requirements.

The operation of the carriage return has now been included on the keyboard and there are repeat keys for such purposes as underlining and vertical columning. All normal operations can now be controlled from the keyboard. There are 10 degrees of impression pressure allowing up to 20 copies to be made at a time, and a lever adjusts the platen to suit the number being made.

Other changes include a new feed roll mechanism; an automatic fabric ribbon feed with the spools held in by magnetism; proportional feed for the carbon paper ribbon with no feed for the space bar; and an easily removable cover giving full access. *IBM United Kingdom Limited, 101 Wigmore Street, London, W1.*

HOSE COUPLING

Quick Release Unit for Fluid Lines

THE Binks quick release coupling for lines carrying fluids is now available in this country.

It offers a bayonet type operation with good sealing, and when used with a paint gun allows the operator to change from one colour to another without the bother of cleaning out the hose lines or the container.

The coupling consists of two sections, the body assembly which is attached to the fluid hose, and the stem assembly which is attached to the fluid connection of the spray gun. A connector is also supplied for joining the coupling to the hose itself.

The basic unit comprises an E62 body assembly in conjunction with an E60 $\frac{3}{8}$ in British standard pipe thread stem assembly. Alternatively, the E61 $\frac{9}{16}$ in by 20 threads per inch stem assembly can be supplied. It is claimed that the coupling is compact, hard wearing and foolproof. *Alfred Bullows and Sons Limited, Long Street, Walsall, Staffordshire.*

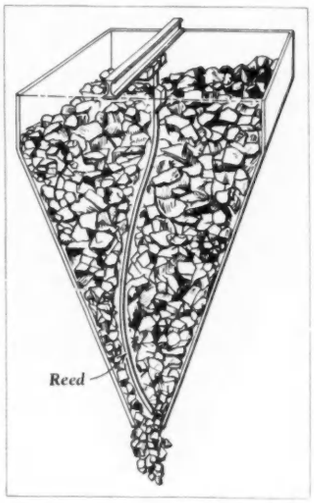
BUNKER VIBRATOR

Internal Unit for Steel or Concrete Hopper

THE Sinex internal vibrator can be used in large concrete bunkers to which external types cannot be attached.

The device consists of a rotary electric vibrator attached to a steel reed which hangs down into the bunker. The complete assembly is suspended from a rolled steel joist across the top of the bunker by means of anti-vibration mountings which isolate the hopper structure from vibratory effects. When the equipment is in operation the vibration passes down the reed with increasing amplitude, reaching a maximum at the lower end of the reed where the material has a tendency to arch. As vibration loosens and releases the material, the pressure of the latter on the reed varies and causes it to bend and move about the hopper; vibration is therefore always applied at the most needed point and thus ensures complete discharge of the contents.

Constructed of mild steel, the reed is made up to suit the depth of the hopper for which it is required. Its dimensions



vary between 18 and 24 in wide, $\frac{1}{8}$ to $\frac{3}{8}$ in thick and up to 60 ft in length. *Sinex Engineering Company Limited, North Feltham Trading Estate, Feltham, Middx*

JIGSAW

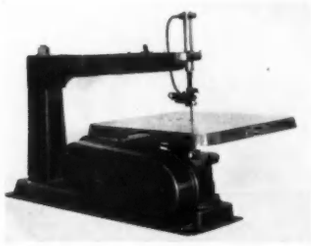
Bench and Floor Mounting Models

A RECENT addition to the Pacera range is a jigsaw with a 25 in throat. Bench and floor mounting models are available.

The machine has a capacity from blade to frame of 25 in and under the foot of 2½ in. The stroke of the blade is 1½ in. The standard work table measures 18 in by 18 in and will tilt through an angle of 45°. It is made of ribbed cast iron with a brass insert. Mounted below it is a degree scale showing the angle of tilt.

The saw is driven by either a single phase ½ h.p. motor or a ½ h.p. motor for three phase supplies. Both run at 1,425 r.p.m. Four speeds are available by the use of cone pulleys, giving a range from 555 r.p.m. to 1,460 r.p.m.

The main shaft and crank wheel are of one piece construction and are ground throughout; the shaft runs in ball bearings with splash lubrication. The drop forged steel reciprocating rod operates in a bronze bush and also has a phosphor bronze slider.



Tension in the saw is adjusted by the pump cylinder in the head which is fitted with a cast iron clamp and a large locking screw. Heavy duty vice type blade holders that can be rotated through 90° can be supplied as extra. It is recommended that blades or files for use in the machine should be 6 in long.

Overall dimensions of the bench model are 41 in long by 18 in wide by 24½ in high. The table height is 12 in and the net weight 190 lb. The floor mounting pedestal has a height of 24 in and adds 70 lb to the weight. *W. J. Meddings Limited, 535-541 Ipswich Road, Trading Estate, Slough, Bucks.*

FLUORESCENT WORK LIGHTS

Portable Safety Models

TWO models have been added to the A.103 range of fluorescent work lights.

As with the basic type, the new models consist of a 2 ft 20 watt fluorescent tube fitted in a metal reflector with an adjustable joint at one end and mounted on a hollow cast aluminium base which contains the control gear. The reflector can be positioned anywhere between the horizontal and vertical and also rotates about its own axis.

The first is the type A.103/G for use in garages and vehicle workshops, and the design meets LCC requirements under the Petroleum (Regulation) Acts of 1928 and 1936.

The second model the Type A.103/D was specially designed for use in telephone exchanges and similar electrical installations. It is a safety and shockproof model with double insulation throughout to BS 2754. The fluorescent tube is protected by a clear "Perspex" or amour plate glass shield.

Standard models are for use on 200/250V, a.c. mains but models can be

made for non standard voltages and frequencies. *P. W. Allen and Company, 253 Liverpool Road, London, N1.*

5 INCH CENTRE LATHE

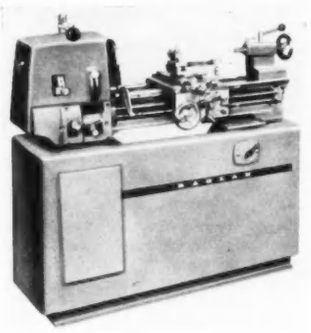
Works to Fine Limits

THE Raglan 5 in centre lathe was shown at the Lisbon Fair. It is robustly constructed and is capable of working to fine limits.

While retaining most of the features of the "Little John" lathe, many refinements have been added, including a completely redesigned saddle. This is of ample proportions with power longitudinal and cross feeds, a safety interlocking device and automatic knock-off to the longitudinal traverse. A 4-station stop is an optional extra.

The headstock and bed are a one piece casting with hardened and ground slides. There is ample chip clearance and all controls are conveniently situated. An optional extra is the quick change gearbox.

The main spindle is fitted with Timken taper roller bearings and any desired speed is obtained by the stepless variable speed drive. The higher speed range employs an all belt drive with no running gears, while slower speeds are obtained by back gearing.



The rigid fabricated metal stand has a flush top without a tray and can therefore always be kept tidy and clean without effort. There is a sloping chute for the easy clearance of cuttings, a cupboard, a tool tray and provision for a suds unit.

There is a wide range of accessories and a modified model is available specially for the rapid and semi-automatic turning of test pieces. *Raglan Engineering Company (1954) Limited, Raleigh Street, Nottingham.*

PART CLEANERS

Belt and Flight Conveyor Units with Spray Washing

A NEW range of Efco standard industrial spray washing equipment comprises single and two-stage machines fitted with either mesh belt, flight bar or overhead monorail conveyors. All machines can be supplied with drying sections if required.

In operation, the parts to be cleaned are loaded on to the conveyor and carried through a steel canopy where they are sprayed from top, sides and bottom with pump-circulated cleaning agent from stainless steel nozzles. Vertical monoblock pumps are employed which eliminate external pipework and gland spillage. The two canopy openings are provided with internal lip extraction ducts, connecting into fume extraction stubs mounted on top of the machine.

The solution tank is fitted with removable covers and a quick-release door. A quick-filling water service connection is provided, with a float valve to maintain the cleaning agent at constant level during operation. An overflow weir

prevents overfilling and enables floating contaminants to be removed.

Pump output is rated to permit solids to settle before recirculation of the cleaning agent and delivery is controlled by a hand valve. The pressure and temperature gauges are flush mounted in a sealed chamber. Heating is by gas, high pressure hot water, steam or electricity as required.

The standard range of sizes includes conveyor widths of 18 in, 24 in and 30 in for the belt and flight bar machines. Variable speed drives and special heavy duty conveyors are available as optional extras. *Electro-Chemical Engineering Company Limited, Woking, Surrey.*

PEAK PRESSURE INDICATOR

For Diesel Engines

THE Diesindicator has been designed to register accurate peak and initial cylinder pressures upon a clear dial-type gauge and thus provide immediate visual readings.

It is suitable for low, medium and high speed diesel engines where access to the combustion chamber is provided; it is applied simply and quickly and can be used in either vertical or horizontal positions.

As no piston or damper is incorporated, inertia is minimised and carbon deposit is very greatly reduced, with the result that the instrument will continue to operate effectively for from 75 to 100 applications without sooting-up, while the ultimate cleaning of the internal cartridge can be carried out easily.

Special heat, shock and corrosion resisting materials are used in the construction of this instrument. The gauge reads up to 2,000 lb and is graduated both in lb per sq. in and kg per sq. cm. *Dunedin Engineering Company Limited, 73-75 Mortimer Street, London, W1.*

HORIZONTAL DRILL

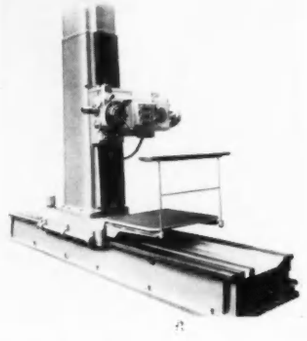
For Large Cumbersome Components

Now available in this country are the Kolb horizontal drilling machines that have been produced for working on large and cumbersome components.

There are four machines in the range with capacities from 40 mm (1 9/16 in) to 120 mm (4¾ in). On the largest model there are 24 or 36 spindle speeds giving a coverage from 10 to 1,000 r.p.m. The drilling motor is 18 h.p. and the drilling pressure that can be applied is 4,500 kg. The machine will drill up to 4¾ in diameter in mild steel or 5½ in diameter in cast iron; it will bore up to 16 in diameter in cast iron. The quill travel is 25½ in.

The bed measures 57½ in long and 21⅜ in wide. The drilling head has a vertical travel of 86 in and the maximum distance between the spindle and the bed is 122 in; the minimum is 35 in.

There are two gear drives incorporating electromagnetic clutches, one for the horizontal travel of the column and the other for the vertical travel of the head. Both have slow and rapid movements.



In addition, the column has a creep travel for positioning supplied from a separate motor. Model HB65 also has this creep travel for the vertical adjustment; the others have a fine hand control.

The travel movements can be switched to inching or continuous as desired, and the operator's platform on the larger machines travels with the slide. *Stanley Howard Limited, 73 Devon Street, Saltley, Birmingham, 7.*

DIESEL DUMPER

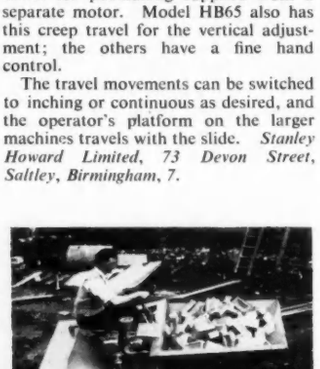
15 Cwt Capacity 12 m.p.h.

The Nimbus T3 dumper has a capacity of 15 cwt and a top speed of 12 m.p.h.

Other special features claimed are a reduced number of moving parts; a turning circle of less than 7 ft 9 in radius, and a very low centre of gravity.

Power is supplied by a Petters AVA1 single cylinder air cooled diesel engine driving through a three speed and reverse, constant mesh gearbox. The speed range is from 2 to 12 m.p.h. forward and 2 m.p.h. in reverse. The transmission includes a foot operated clutch with an extra large contact face and a slow running ¾ in Renold chain driving from the half speed shaft of the engine to the gearbox. Gear changes can be made on the move without stopping the truck.

The steering axle is fully floating and is centre pivoted. Ackermanm worm and cam steering is used. The chassis is made from 3 in by 2 in steel channel with reinforcement where required. Both driving and steering wheels are



steel pressings, the former having 5 stud and the latter 3 stud fixing. Tyres are 6 by 16 and 5 by 16 respectively.

The skip is made of ⅛ in steel plate with a hand lever locking catch; a discharge lip can be supplied as an alternative. Water level is 16 cu. ft; struck-off 18 cu. ft and heaped capacity is 22 cu ft. Unladen the dumper weights 14½ cwt.

The controls are arranged on the right of the driver and consist of the handbrake, gear lever, and skip locking catch as well as the brake and clutch pedals. Both hand and foot brakes operate on the driving wheels. *Thwaites Engineering Company Limited, Cubbington, Leamington Spa.*

TUBE CUTTER

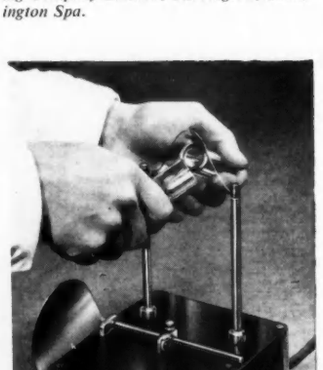
For Hard or Soft Glass up to 3 inch diameter

The Electrothermal glass tube cutter provides a safe and simple means of cutting hard (borosilicate) or soft glass tubes up to 3 in diameter.

On the front of the top plate are mounted the guide, backstop and cutting wheel holder. At the back are two pillars joined by a length of nickel-chrome wire. No special skill is required.

To make a cut the backstop is set to give the required length and the tube rotated against the cutting wheel to make a scratch round the circumference. Power is switched on and the crack mark held against the red hot wire to cause the crack to run and part the tube. The process takes a few seconds but can be accelerated by removing the tube from the wire and touching it with a damp rag.

Power to heat the wire is supplied from a double wound transformer which has a screen between the primary and secondary windings. It can be used on 250 or 110 V supplies. The nickel-chrome wire used is 27 s.w.g., and the head is supplied with six replaceable



cutting wheels. *Electrothermal Engineering Limited, 270 Neville Road, London, E7.*

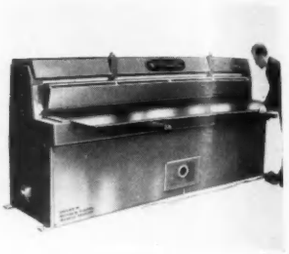
GUILLOTINE

All Steel Frame, Vibrationless Action

A distinctive feature of the Besco-Truecut range of metal guillotines is the adoption of an electrically operated friction clutch and brake giving silent, vibrationless operation.

Other features include: main frame of steel plate welded together as one unit; precision gauges; dry type low friction wearing strips to the cutting beam slides; clean cut outline with no moving parts outside the frame; and a worm reduction gearbox drive.

The electrically operated friction clutch is incorporated in the flywheel. This clutch is self-adjusting and is engaged from a floor-mounted remote controller. The machine is arranged for single stroking or continuous action, and is controlled by a conveniently situated selector switch. The whole of the drive is contained under the bed and is easily accessible for servicing. There is a push-button station mounted at one end of the bridge piece, with stop and start buttons and a "motor running" warning light.



The machines are fitted with a precision dial type calibrated rear gauge, standard front and side gauges. A side squaring gauge is available. A clear view "disc spring" operated inclined hold-down, with anti-slip inserts on the gripping pads, is also fitted. The inclined position gives the operator full view of the cutting line.

The range comprises seven models: 6 and 8 ft machines to shear up to 14 s.w.g. mild steel sheet, and 3, 4, 6, 8 and 10 ft machines to shear plate up to ⅛ in thick. Non-ferrous metals and a wide variety of other materials can also be sheared. *F. J. Edwards Limited 359-361 Euston Road, London, NW1.*

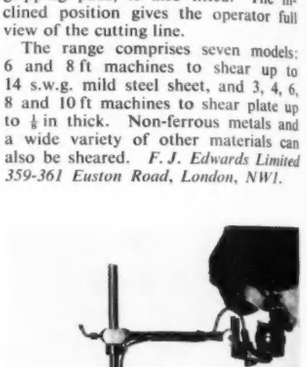
MAGNIFIER

Stereoscopic View of Work Area

The Sterimag is a low power stereoscopic magnifier with a wide field of view and considerable depth of focus.

The miscoscope head is fitted to a substantial long arm stand with a heavy base, which is the most generally useful type of stand for this sort of microscope as it allows a wide range of objects of different sizes to be examined conveniently, and allows the microscope head to be swung aside when not in use. The optical head is fitted with a swivel joint so that it can be used in an inclined position, and the instrument can be bought with a built-in spot lamp, supplied from a transformer housed in the base.

Two models are available, one with a magnification of × 20, which has a field of view which can be seen at one time of 10 mm diameter, and one of × 10 magnification with a field of view of 20 mm. Large objects can be examined by moving the microscope over the object. Each model has a free working distance of approximately 7 in from the object to the microscope head.



The Sterimags are useful in production inspection, in the tool and cutter grinding department, to examine cutting edges, for floor inspection for quality control, for assembly of small components, for example, valves and small electronic assemblies, and for mounting on machines for observing delicate operations. In laboratories Sterimags are used for dissecting, counting, examining products and materials and in many other ways.

The object is seen magnified, right way up, with great depth of focus and a wide field of view. The price is said to be reasonable. *C. Baker Instruments Limited, Metron Works, Purley Way, Croydon, Surrey.*

STUD WELDER

For Standard Transformer Units

Stud welding equipment for use with standard arc welding transformers has been introduced. The capacity for mild steel studs is up to ⅜ in diameter.

The controls are contained in a single unit which, when installed on the primary side of the welding transformer, can be used for either arc or stud welding by a selector switch. The pistol-type hand tool, which is designed for use with Philips' stud welding cartridges, weighs only 2½ lb and has an overall length of 8½ in when welding 1 in long studs. It is fitted with a new type of locating foot that is claimed to give very accurate positioning.

The standard hand-tool is supplied with six collets from 3/16 in to ⅜ in diameter and will accept studs up to 3¼ in long for 3/16 in diameter and 3¼ in long for ⅜ in diameter. The equipment will also weld cheese-headed screws down to 6 B.A. The body is aluminium-alloy casting, in the butt of which is a locking screw adjustment which controls spring pressures suitable for all positional

welding. *The Stud Welding Applications Company, Roads Estate, 307 Richmond Road, Twickenham, Middlesex.*

MORE ABOUT LIQUID METHANE

Recent experiments on the transportation of liquid methane by sea have again been brought to the attention of the Commons; this time as a result of questions put to Mr. Reginald Maudling, the Paymaster-General, by Mr. Alfred Robens (Labour).

The various points raised by Mr. Robens were answered by Sir Ian Horobin, the Parliamentary Secretary to the Ministry of Power. He stated that, to date, the gas industry's share of the expenditure on the research and experimental work amounted to rather less than £1½ million, mainly spent on the oil tanker and onshore installations in this country. Both of these undertakings, he pointed out, would have a considerable residual value, even if the experiment did not warrant further development. Account had been taken of this investment by Lord Mills, the Minister of Power, when giving general consent to borrowings by the Gas Council.

Investment by the Gas Council in the joint company which owns the experimental liquid-methane tanker was subject to approval by Lord Mills and had so far been limited to the requirements of the experiment. Lord Mills did not intend to consider any application to increase the Council's investment until he had received a full technical and economic assessment of the results of the trial shipments.

Costs of producing town gas varied very widely according to the circumstances of production and demand. Average cost in the London area for production from coal and oil was roughly 16*d* and 14*d*, respectively, per therm. No assessment was possible at present as to the cost of producing town gas from methane.

EXCHANGES OF PLUTONIUM

British nuclear power stations are to be operated first and foremost for the generation of electricity and their output of the by-product plutonium will depend directly upon the amount of electricity produced. Mr. Harold Macmillan, the Prime Minister, said that the plutonium production of the reactors would be unaffected by the amended agreement with the United States on cooperation in the use of atomic energy for defence purposes.

He told Mr. William Warbey (Labour) that this statement did not mean that he (Mr. Macmillan) could give a definite assurance that there was no question of there being any modification of the design of atomic power stations in order to produce a greater proportion of plutonium than electrical output. Britain had already installed certain ancillary plant in the first atomic power stations which now existed.

Any plutonium which the Government might exchange with the United States would come either from the civil nuclear power stations or from the United Kingdom Atomic Energy Authority's own reactors at Calder Hall or Chapel Cross.

IRISH-JAPANESE SEWING MACHINES

Some particulars of recent imports into the United Kingdom of domestic sewing machines from the Republic of Ireland were supplied by Mr. J. K. Vaughan-Morgan, Minister of State to the Board of Trade. The figures showed a sharp upward tendency during recent months and were as follow:—

Period	Number	Value in £
1957	3,382	38,126
1958	11,369	162,946
1959 (Jan.-March)	7,326	112,091

Mr. Vaughan-Morgan said that these machines were entitled to duty-free entry into the United Kingdom if they were manufactured in the Irish Republic and complied with certain other prescribed requirements. When it was pointed out by Mr. Charles Royle (Labour) that, according to his information, these sewing machines were coming from Japan in a knocked-down state and being reassembled in Eire and then re-exported to this country, Mr. Vaughan-Morgan said that he would certainly look into the matter. To qualify for preference, at least 50 per cent of their cost of manufacture must be attributable to Commonwealth expenditure. Simple assembly operations alone would not entitle the machines to be treated as being made in Eire.

PROTECTING INDUSTRIAL DESIGNS

A review is to be undertaken of the existing law relating to the protection of industrial designs. Mr. John Rodgers, the Parliamentary Secretary to the Board of Trade, said that, with this end in view, the President of the Board of Trade had appointed a committee.

The terms of reference of the committee would be: " To consider and report whether any, and, if so, what, changes are desirable in the law relating to the protection of industrial designs. In framing their recommendations, the committee should include consideration of the desirability of enabling United Kingdom designs to receive cheap and effective protection in other countries on the basis of reciprocity."

Mr. Rodgers said that Mr. Kenneth Johnston, Q.C., had consented to become the chairman of the committee. He assured Mr. Richard Hornby (Conservative) that the committee would press ahead with their review with all possible despatch.

REPAIR OF RAILWAY WAGONS

Asked by Major Sir Guy Lloyd (Conservative) about the allocation of wagon repairing work by the British Transport Commission between their own workshops and private firms, Mr. Harold Watkinson, the Minister of Transport and Civil Aviation, said that this was the responsibility of the Commission. It was not a suitable subject for a direction from him.

He was aware, however, of the concern felt by private wagon repairing firms as to their future. He had received a deputation from the Wagon Repairing Association and had discussed the matter with Sir Brian Robertson, the Commission's chairman. The problem arose basically because British Railways wagon fleet was being contracted very materially and because the older wooden wagons were being scrapped. In allocating repair work, the Commission must have regard to commercial and geographical considerations as well as to the claims of their own workpeople and of the private repairing industry.

The Commission had already reduced the volume of repair work in their own workshops and was discussing with the unions the effects which further contraction would have on their shops. The Commission was also meeting the Wagon Repairing Association to discuss how best the continuing contraction could be applied in their case.

BRITAIN IN THE COMMON MARKET

Various members inquired about the problems confronting the United Kingdom in relation to the European Common Market. Mr. E. H. C. Leather (Conservative) wanted to know what were the principal Commonwealth imports into the United Kingdom covered by the terms proposed for her membership of the Common Market.

Mr. F. J. Erroll, the Economic Secretary to the Treasury, said that if the United Kingdom were to become a member of the European Economic Community on the same terms as the present members, the common external tariff of the six countries would apply to Commonwealth goods entering the United Kingdom, including foodstuffs and raw materials. This would mean that over a wide field Commonwealth goods would cease to enjoy free entry into the United Kingdom. It was not possible to give the exact percentage which the items concerned made of the total of imports from the Commonwealth. The common external tariff of the Six had not yet been finally worked out.

He told Mr. Douglas Jay (Labour) that commodities which were admitted duty free into this country and which, as far as was known, would be admitted duty free into the Common Market countries amounted to only about 15 per cent of the total Commonwealth imports into this country. When Dr. John Cronin (Labour) asked for a statement of the Government's policy regarding the formation of a European free trade area which would not include the Common Market countries, Mr. Erroll said that a multilateral association of the members of the European Economic Community with the other members of the Organisation for European Economic Cooperation remained the objective of the British Government. They would continue to examine all possible steps which might help towards that end, including an association of the kind that Dr. Cronin had referred to.

Mr. H. D. Oakshott (Conservative) paid a tribute to work done by Mr. Reginald Maudling, the Paymaster-General, as chairman of the Inter-Governmental Committee of the OEEC.

Entries for Diploma in Technology

The Minister of Education was asked by Mr. Austen Albu (Labour) for information about entries for courses leading to the Diploma in Technology. He was informed by Mr. Geoffrey Lloyd that information supplied by the colleges conducting such courses showed that 1,529 students now enrolled in these courses had qualified for entry by the general certificate of education and 820 by the ordinary national certificate.

British Books Abroad

Information was sought by Colonel Tufton Beamish (Conservative) regarding the sale of British books and periodicals abroad which were being adversely affected by books in English, from foreign sources, being sold at excessively low prices. Dr. Charles Hill, the Chancellor of the Duchy of Lancaster, told him that there had been very large exports of books and periodicals in the English language at low prices by several countries, including particularly the Soviet Union and China. These exports had been developed primarily for propaganda purposes and, in the main, they did not seem to have affected commercial sales of British books. He hoped to announce very soon the results of a study by the Government into ways of encouraging the flow of British books overseas.

Millions for Coal Gasification

According to another reply given by Sir Ian Horobin to Mr. Alfred Robens, nearly £1,250,000 has been spent on research into the gasification of coal since the nationalisation of the coal industry. In addition, the Gas Council had undertaken the construction of a new type of high-pressure gasification plant on a commercial scale, at an estimated expenditure of some £5 million. In order to solve chemical engineering problems, this plant will be used initially to gasify oil, but, in its final development, the plant is intended for the gasification of small coal.

Damage by Transmission Towers

It was suggested by Mr. Marcus Kimball (Conservative) that the Paymaster-General should have consultations with the electricity boards with a view to preventing " widespread and unnecessary " damage to growing crops when transmission towers are erected on farmland. Sir Ian Horobin replied and stated that Lord Mills, the Minister of Power, was satisfied that the electricity boards and their contractors were anxious to keep damage to a minimum. The boards were required by statute to make full compensation for damage and, in the event of a dispute, the amount would be settled by an arbitrator appointed by the minister. In the particular case which Mr. Kimball had in mind, the Central Electricity Generating Board had kept in touch with the local branch of the National Farmers' Union which they consulted respecting restoration.

Contradictory Steel

There has been a marked difference in the performance of British steel-making concerns during the past financial year. Most of those manufacturing light rolled products have achieved record results, due mainly to the high level of activity maintained by motor vehicle manufacturers. Producers of heavy steel products and castings have done much less well, reflecting the marked slowing down in the shipbuilding, railway rolling stock and other sections of heavy engineering. The most distressing change of fortunes, however, has been in the special-steel section of the industry. A considerable slackening of demand has taken place, probably reflecting a general tendency in the engineering industry to run down stocks of high cost materials.

Two of the largest makers of light rolled products, the Steel Company of Wales and John Summers and Sons, issued very encouraging statements. John Summers' trading profit before tax for the half year to 4 April was maintained at a slightly higher level than the corresponding period of 1958. The directors' report states that the demand for sheets and light plates from a wide range of industries has been maintained at a level more than sufficient to absorb the maximum production of existing sheet rolling and finishing capacity at their Shotton works. In May this year the company's commitments to customers "absorb the full estimated production to the end of the financial year." SCOW produced 2,247 tons of ingots more during the second week in May than had ever been produced at their Port Talbot, Margam and Abbey works, total output being 52,828 tons. During the same period the universal slabbing mill at Abbey works rolled 57,065 tons of ingots into slabs.

Companies such as English Steel Corporation and Colvilles, on the other hand, and Darwins in the special-steel field, were sorely tried by receding demand. English Steel's output during 1958 was 77,000 tons lower than in 1957 and 85,000 tons below the record level of 590,000 tons achieved in 1956. Their chairman, Sir Frederick Pickworth, commented that "although there had been no further falling off in orders since the latter part of 1958, prospects of a return to the activity of 1957 are not yet apparent." During the same year Colvilles Limited did no better. Their chairman, Sir Andrew McCance, was unable to foresee the end of difficulties but the company are nonetheless proceeding with their scheme for a major extension of their Ravenscraig works which will provide "ample capacity to meet the demands of the available market and to allow for the expansion of this market in the foreseeable future." Darwins' performance in 1958 was described as "very disappointing" by their chairman, Mr. F. Thompson-Schwab. Demand for their products declined faster and further than they had anticipated and trading conditions during the second half of the year were said to be "extremely difficult." Deliveries declined by nearly one sixth to £5·17 million and trading profits were almost halved. The group's plants were working below capacity earlier this year and recovery is expected to be slow.

Krupp and Thyssen

The annual statements of two of Germany's steel and heavy engineering giants, Friedrich Krupp of Essen, and August Thyssen-Hütte Aktiengesellschaft, Duisburg-Hamborn, suggest that the period of breathless expansion of the past few years is ended. The directors of ATH state quite bluntly that during the financial year ended 30 September, 1958, "the rapid upward trend was interrupted for the first time since the reestablishment of our company. In consequence of the general market recession, it has not been possible since February, 1958, to utilise our steel capacity fully. We produced in the second half of 1957-58, 18 per cent less crude steel and rolled steel than in the first half while sales declined simultaneously by about 11 per cent." They talk of "stiffening competition." Due to the substantial reconstruction of their plant, however, ATH were able to increase production and sales and to consolidate further their market position. Nonetheless, the report states, "aligning our production to the changing and generally declining sales possibilities led to fluctuations in production and sales which considerably taxed the adaptability of our works." The earnings of most companies in the group were reduced by higher costs and lower prices obtainable for a number of their products. Close attention is being paid to productivity, mainly through plant development. The group expect to improve their competitive position during the current year and hope for a recovery in demand. They put down most of their difficulties to reductions of "excessive inventories" of dealers and customers and conclude that "the cycle of inflated inventories is considered likely to run out in the near future. Moreover, the considerable steel requirements of underdeveloped countries should in due course stimulate demand for steel in the world markets."

Krupp have suffered less from the trade recession than ATH—they maintained their turnover at about DM2·308 million (compared with DM1·776 million in the case of ATH)—but are less hopeful concerning the future. Their chairman and sole owner, Herr Alfred Krupp von Bohlen und Halbach, emphasised that "there is little room for exaggerated hopes in the future." The present volume of orders on hand is "in accordance with our moderate expectations" and the group's plants are adequately employed. The labour force, however, was reduced by some 2,000 during the year, to 52,000. Herr Krupp had much to say about exports (they account for 22 per cent of their turnover with external customers) and the common market: he sees in the latter important possibilities for concentration of European industry with considerable gains in efficiency (as did ATH). Herr Krupp recently left Germany with his son for Japan, "to study the economic possibility of foreign countries, with a view to possible forms of cooperation whenever a suitable opportunity presents itself."

Firm Foundations

Increased profits for both George Wimpey and Company and Taylor Woodrow are the highlights of these two companies' annual statements. In the difficult circumstances which prevailed last year this is a very satisfactory achievement. Another cheerful item of news is the opening of new offices and works at Bromborough, Cheshire, by Holland & Hannen and Cubitts.

Sir Godfrey W. Mitchell, chairman of Wimpey, told a long story of vast contracts and enterprise. Their profits in 1958 were close to £5 million, £225,000 more than the previous year. Sir Godfrey explained that their rate of activity was much higher than they expected, due to the decline in the amount of work available to the industry because of the credit restrictions imposed by the Government. During the calendar year they completed more than 8,000 flats and houses for public authorities, of which 6,575 were constructed in Wimpey "no-fines" concrete. This material was used for the first eleven-storey development in Cardiff and for the multi-storey block of 160 flats built for the Gateshead Borough Council which is the largest single block of dwellings built in Britain since the war. In addition they built 3,000 houses for private purchase and were developing 100 private housing estates. Considerable factory and office building also took place as well as large civil engineering contracts and the specialised construction of refineries, petrochemical plants and chemical factories. Sir Godfrey Mitchell gave no hint of any slackening of this very high rate of activity; on the contrary, he expressed his confidence that "in the absence of a further contraction in the economy" the present year would be equally successful.

Taylor Woodrow's trading profits were also higher than in 1957, £1·95 million compared with £1·89 million on a turnover of £27 million as against £22½ million in the previous year. Their chairman, Mr. Francis Taylor, explained that contracts "of the right type" were becoming more difficult to obtain in the latter half of 1958, but pointed out that the reductions in the Bank rate and the suspension of Government control of borrowing should assist towards increasing the volume of building and civil engineering work available. For Taylor Woodrow, as well as for Wimpey, the year was one of great activity, despite increasing competition. Among the major contracts on which they are currently working are a factory for Unilever in Belfast; the laying of submarine pipelines in the United Kingdom (in association with the Collins Construction Company of Texas) and the constructional work on the Hinkley Point atomic power station and the second station at Calder Hall. Like his colleague, Sir Godfrey Mitchell, Mr. Taylor looks forward to good results during the current year.

Costain & Cubitts & Laing

Cheerful news has come from these three famous contracting organisations in recent weeks. Sir Richard Costain, chairman of Richard Costain Limited, reported the highest trading profits in the company's history. Performance during 1958 was outstanding in all fields, with exports accounting for 65 per cent of the group's turnover. They are continuing to widen their overseas ramifications, the latest step being the acquisition of a controlling interest in Costain (West Africa) Limited in Nigeria where work in progress is at a high level. The company's order book at the end of 1958 was approximately the same as at the end of 1957 and Sir Richard Costain feels confident that results during the current year will be no less favourable, provided there are no major political upheavals. The fact that so much of the company's work is abroad—a substantial proportion of it on the African contient and in the Middle East—must introduce an element of risk in what is otherwise a very strong position. At home the order book is higher than it was a year ago and inquiries are coming in at a higher rate.

Holland & Hannen and Cubitts (North West) Limited opened new offices and works at Bromborough, Cheshire. These buildings marked the climax of fifteen years of rapid development by Cubitts in the area. Cubitts (North West) started operations in 1945 with one job worth £17,000: their current order book stands at over £6 million. Their very first job there was in Liverpool just before the First World War, when they erected the Cunard building on the waterfront. The parent company was founded in 1815, and their development was largely based on the new methods introduced by the founder, Thomas Cubitt, who introduced overall planning in building and set the pattern that all major contractors have followed ever since. London bears their mark in many famous places: they built the Tate Gallery, Euston station, South Africa House, Harrods, Unilever House, the Cenotaph, and many other landmarks. They have pioneered construction work overseas, including some very large schemes.

John Laing and Son Limited continue to widen their activities. Two new companies have just been formed—Ground Engineering Limited, who will be concerned primarily with soil mechanics and site investigation services as a preliminary to all classes of construction, and McKinney Foundations Limited, who have been established in association with an experienced American organisation for the design and construction of bored pile and caisson foundations.

Super Diploma

For some time now it has been an open secret that students at technical colleges have been choosing the B.Sc. qualification in preference to the Dip. Tech. One can probably attribute this to the newness of the award and to the influence of parents towards the degrees they themselves know well. There is little doubt, however, that industry is similarly affected and that graduates have found a traditional degree opened more doors, and wider. The national Council for Technological Awards probably had this in mind when they decided to establish the College of Technologists.

Membership of the new college will be granted to students who complete a substantial programme of work on a problem, the solution of which is of value to industry. Part of the task will have to be carried out at a technical college, part in industry. The MCT award will broadly correspond to the academic discipline of a Ph.D. and to its status. The college of Technologists will operate within the framework of the National Council and will be served by the same administrative staff. Its establishment was foreshadowed by Lord Hives, chairman of the National Council, towards the end of last year. A board of scientific and industrial studies is to be set up to assume the responsibilities for the academic and industrial aspects of the administration of the award. Sir Arnold Hall, managing director, Bristol Siddeley Engines, has been appointed chairman.

A distinguished scientist, Dr. Samuel C. Curran, F.R.S., has been appointed principal of the Royal College of Science and Technology Glasgow, in succession to Sir David Anderson, who is retiring later this year. Dr. Curran, who is 47, is a graduate and Ph.D. of Cambridge University (St. John's). He did post graduate work at Glasgow university and taught there. He is at present chief scientist, responsible for the divisions of nuclear research and electronics, at the Atomic Weapons Research Establishment, Aldermaston.

Workless Dwindle

On 11 May the total of unemployed in Britain was 481,000 which brings the level of unemployment down to 2·2 per cent. The fall below the half million mark takes the total to the lowest point since last September and the decline has been going on for four months. The same trend is expected to continue in the fifth month. Earlier in the year this drop could be put down to seasonal influences but it is now persistent and can only mean that the level of unemployment is reacting favourably to the end of the recession.

There has been an encouraging improvement in the absorption of school-leavers into the labour force and it is perhaps also significant that the improvement over the latest month this year compares with a worsening position in the same month a year ago. A further good feature is that the percentage drop was greatest in the areas worst hit, such as Scotland and Wales. The smallest improvement was in the London area, which was one of those least affected right through the recession. But there are still a significant number of workers on short time: some slack remains to be taken up and there may well be scope for some redistribution of labour now that expansion appears to be set fair for the rest of 1959.

Docks Disease

During 1958 the trend was towards a smaller labour force at the docks. According to the annual report and accounts of the National Dock Labour Board for 1958, this downward trend was reversed, however, to some extent in the opening weeks of the current year. The basic reason for the drop last year was the decline in international trade; and the persistent fall in employment at the docks forced the Board to adopt more stringent measures by October to control registers of workers.

An investigation of age groups showed that there was a tendency for the average age of dockers to increase compared with the position say five years earlier. Last year the rise in unemployment caused a relatively larger proportion of men in their prime to look for other work and this left a markedly higher proportion of men in the industry between the ages of 55 and 59. This relative growth of the older age groups may be of significance in the future, according to the Board, if registers have to be stabilised.

Average weekly gross earnings of dockers last year were 13 guineas. This inevitably averages a fairly wide range of earnings across the country. In 1957 average earnings were £13 16*s* 6*d*.

A Thousand Scholars

The largest Commonwealth education conference ever to be held will begin in Oxford on 15 July. For two weeks more than 150 delegates from all Commonwealth countries and 15 Colonial territories will formulate a new programme of Commonwealth scholarships, and will review the existing arrangements for co-operation on all aspects of education. Among the subjects on the agenda are technical education (the initiative taken by the Duke of Edinburgh—discussed in Human Element last week under the heading Commonwealth Training—will doubtless be a spur to new achievements), the supply and training of teachers, and interchange of university staffs and other matters mentioned in the report of the Montreal Conference of Commonwealth Ministers last September.

At the Montreal Conference it was envisaged that within a few years there would be 1,000 Commonwealth scholars. The United Kingdom undertook to be responsible for half this total, and Canada for one quarter. Lord Halifax, chancellor of the University of Oxford, will be president of the conference and Sir Philip Morris, vice-chancellor of Bristol University, will be chairman. The UK delegation will be representative of all interested Government departments, the British Council, local education authorities, teachers, universities, technical colleges and teacher training colleges.

All the World's Teachers

The quest for education continues to gather momentum all the world over. News received recently from the United States and USSR and from our own Association of Teachers in Technical Institutions points in the same direction. Great efforts are being made in all three countries to develop the personality and understanding of the young, and to equip them with the specialised knowledge they need to play their part in the technology of our time. The appointment of a classical scholar to the senior tutorship of Churchill College, Cambridge, demonstrates that in the view of the leaders in the profession, all types of teachers and many subjects must be combined to achieve such aims.

The ATTI held their annual conference from 15 to 18 May in Leicester. Much of their time was taken up by a discussion of the McMeeking report, prepared by the Advisory Committee on Further Education for Commerce. This called for a large expansion of commercial education in order to make effective " the efforts to expand and improve other sections of technical education." Among the many resolutions before the conference was one calling for improvements in secondary education, with emphasis on the reduction of the size of classes (in primary as well as in secondary schools), on more teachers and better facilities for teacher training and education and on improved accommodation. Another resolution called for immediate improvements in the facilities available for apprenticeship and training, urgent because of the entry into the labour market of the bulge in school population.

The American publication is entitled *Progress of Public Education in the USA*, prepared by the United States Department of Health, Education and Welfare and reprinted by the United States Information Service in London. It reviews the efforts now taking place to improve education in United States schools. In the scholastic year 1957-58 (which is described as a year of " healthy, self-examination and growth ") American schools reevaluated their programmes in the light of social, economic, and technological changes. The spotlight was on better education, particularly in high schools; on teaching mathematics, science, and foreign languages; and on provision for the gifted. The Soviet report, entitled *Technical and Vocational Education in the USSR*, by M. I. Movsovic and published by UNESCO is a most comprehensive review of what has been published in Russia—much of it by the Government—on technical and vocational education. It provides a very informative picture (by way of extracts from original publications and articles) of what is being done and how.

Yearning for Learning

There were over 11,000 students from the dependencies in the United Kingdom for the current academic year according to a count taken at January, 1959—enough to fill say two large UK universities. Some 4,000 were from West Africa, 3,000 from the West Indies, and over 1,800 from East and Central Africa. The Far East accounted for a further 1,100 or so. Over 8,500 were private students, the rest scholarship holders.

These figures are from a pamphlet issued by the reference division of the Central Office of Information called *Students from the UK Dependencies in the United Kingdom and the Irish Republic*. These students are not the only academic contact with the dependencies however. There exists the Inter-University Council for Higher Education Overseas set up in 1946, which is concerned with the development of university education in the dependent territories. The word " dependent " is in effect a misnomer, for two of the territories, Sudan and Ghana, are now independent, Ghana remaining within the Commonwealth. Two basic principles have been maintained by this body. The first is that high standards must be maintained and for that a high price has been paid temporarily at least in a high teacher-student ratio. The second is that the universities have been fostered as independent corporations and not as near-state departments.

Insuring Teeth

Lack of " bite " is seldom instanced as a shortcoming in employees, but Mr. John Boyd Carpenter, Minister of Pensions and National Insurance, considers it may well be a vital factor in the health of industrial workers. He has asked the Industrial Injuries Advisory Council, whose chairman is Professor Sir Arnold Plant, to consider " whether erosion of the teeth due to acid should be a 'prescribed disease' under the National Insurance (Industrial Injuries) Acts, and, if so, for what occupations."

If a prescribed disease is developed as a result of work in whatever occupations may be specified in the regulations, benefit under the Industrial Injuries Act may be paid for the resulting incapacity or disablement. It has been suggested that the acid given off in some industrial processes, whether in the form of fumes or dust, may damage the teeth of persons working in the immediate vicinity. The council will be investigating whether, if this is found to occur, the resulting erosion of the teeth satisfied the conditions laid down in the Act for prescription. The council invite the submission of information or views on the question.

Gas Cooling Goes Abroad

THE proof of the gas-cooled reactor is in its operation—and in its adoption overseas. In the United States several projects involving gas-cooled reactors have been undertaken and in Europe Krupp and Brown Boveri are cooperating on an advanced system employing fluidised fuel capsules and gas cooling (Atomic Review, 13 February and 2 January). The opening notes are concerned with a number of American gas-cooled reactor projects.

American Gas Cooled Reactors

An information meeting on gas-cooled power reactors was held at the Oak Ridge National Laboratory on 21 and 22 October, 1958; the papers have now been published as a book (TID-7564: $3·50, available from the Office of Technical Services, Department of Commerce, Washington 25, DC). Reference is made to the Oak Ridge gas cooled reactor GCR-2 (Atomic Review, 5 September '58), a design for a 125 MW high-temperature helium-cooled pebble bed reactor, a carbon-dioxide cooled pressure-tube heavy-water moderated reactor concept, the Marine Gas Cooled Reactor (MGCR) project, high temperature systems for nuclear process heat, various advanced systems including the nuclear gas engine, and a group of detailed design studies of gas-cooled reactors by Kaiser Engineers and ACF Industries (Atomic Review, 17 October '58).

Six Kaiser-ACF Gas-Cooled Proposals

Kaiser Engineers and ACF Industries Incorporated have been working on their portion of the United States gas-cooled power reactor programme since October, 1957. During the first phase of this work attention was concentrated on the preliminary design of a prototype natural-uranium fuelled plant. The first phase also included feasibility studies of an optimum sized natural uranium plant (approximately 200 MW electrical), and of a prototype and an optimum sized partially enriched uranium plant. All four designs were based on the use of carbon dioxide gas as the coolant. The engineering of the prototype partially enriched uranium plant was continued into preliminary design status but was discontinued prior to completion because of a change from carbon dioxide to helium as the coolant. A helium-cooled prototype partially-enriched-uranium plant is the object of the current KE-ACF effort, and an optimum plant based on the same system will follow.

TABLE I.—*Comparison of KE-ACF Optimum-Sized Natural and Enriched Gas-Cooled Reactors*

	Natural plant	Enriched plant
Power Plant		
Reactor thermal power, MW	700	600
Net plant electric power, MW	218	203
Pumping power, MW (electrical)	26·2	26·3
Steam cycle	Dual pressure with reheat	Single pressure non-reheat
Steam cycle heat rate, Btu per kWh	9,866	9,058
H.P. steam, pressure, lb per sq. in abs.	1,495	1,095
Temperature, ° F	750	950
L.P. steam, pressure, lb per sq. in abs.	310	
Temperature, ° F	750	
Net plant efficiency, per cent	31·1	33·8
Reactors		
Reactor thermal power, MW	700	600
Active core diameter, ft	46·1	20·3
Active core height, ft	24·0	21·8
Average reactor specific power, MW per tonne of uranium	2·4	10·3
Inlet coolant pressure, lb per sq. in abs.	285	400
Reactor exit carbon dioxide temperature	800° F	1,000° F
Carbon dioxide flow, lb per hour	23,800,000	14,400,000
Fuel Element:		
Maximum design fuel element:		
Temperature, surface	865° F (463° C)	1,200° F (704° C)
centre	1,200° F. (649° C)	4,500° F (2,482° C)
Fuel and cladding materials	Uranium metal and Magnox	UO_2 and stainless steel
Fuel enrichment	Natural	1·8 and 2·2 per cent
Fuel element diameter	1·16 in	0·705 in
Fuel life, MWD per tonne	3,000	10,000

Enriched and Natural Reactors Compared

The optimum-sized carbon-dioxide cooled reactors are compared showing the effects of using enriched fuel. In appearance the natural uranium reactor is similar to the United Kingdom Bradwell station with a spherical pressure vessel, whereas the partially enriched reactor is markedly smaller and contained in a cylindrical pressure vessel with domed ends. Table I gives a comparison of the two reactors, and Table II compares their construction and operating costs.

KE-ACF Helium Cooled Reactor

In addition to a 30 MW (electrical) prototype study of a helium-cooled partially enriched plant, KE-ACF have carried out a feasibility study of a 223 MW optimum-sized plant. The parameters selected are detailed in Table III.

ORNL Gas Cooled Reactor

The Oak Ridge National Laboratory's GCR-2, development of which began in 1957, is basically similar to the Bradwell nuclear power station, but employs partially enriched fuel and helium as coolant. In addition the fuel element consists of uranium dioxide enclosed in stainless steel capsules to contain both particulate activity and the fission product gases that diffuse out of the UO_2 crystal lattice. The reasons for choosing helium as coolant may be inferred from Table IV.

High Temperature Pebble Bed Reactor

A high-temperature gas-cycle graphite-moderated pebble-bed reactor (PBR) of 125 MW (electrical) has been under study by Sanderson and Porter and Alco Products Incorporated for two years. At the same time work has been carried out on closed-cycle gas-turbine nuclear plant. This reactor system is also being developed jointly by the USAEC and the US Bureau of Mines for process heat and by the Brown Boveri—Krupp group for power station use. The present design, the arrangement of which is shown in Fig. 1, employs steam power plant and operates on the thorium-uranium 233 cycle. Major parameters are listed in Table V.

TABLE II.—*Comparison of Costs for KE-ACF Natural and Enriched Gas-Cooled Reactors*

	Natural plant (250 MW (*e*) gross)	Enriched plant (250 MW (*e*) gross)	Difference
Engineering and Construction Costs (millions of dollars)			
Vessel and appurtenances	4·9	2·1	2·8
Biological shielding	5·4	2·8	2·6
Graphite	8·1	1·7	6·4
Controls and instrumentation	6·1	4·5	1·6
Steam generators	14·7	8·7	6·0
Contingency*	16·6	12·5	4·1
Sub total	55·8	32·3	23·5
All other*	54·2	50·7	3·5
Total Cost*	110·0	83·0	27·0
Unit power Costs (mills per kWh)			
Fixed charges	11·9	9·6	2·3
Operating, general and administrative, and maintenance costs	1·5	1·4	0·1
Nuclear fuel	2·3	2·6	(0·3)
Total cost per kWh	15·7	13·5	2·1

* Excluding substation or its contingency.

The cost of partially enriched uranium fuel is approximately four times the cost of natural uranium fuel, and this is not quite offset by the increased burnup of 10,000 MWD per tonne, compared with the exposure of approximately 3,000 MWD per tonne for the natural uranium fuel.

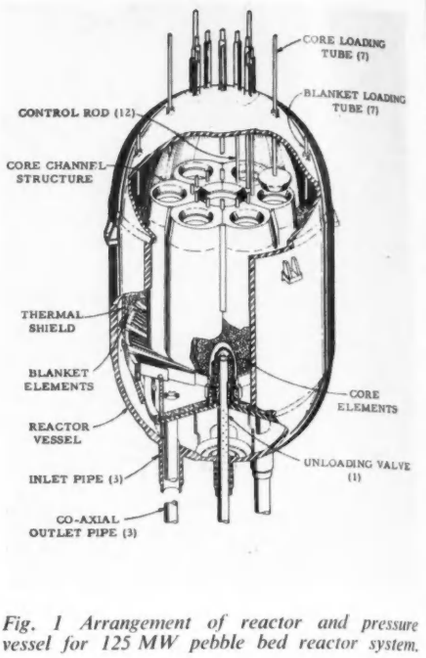


Fig. 1 Arrangement of reactor and pressure vessel for 125 MW pebble bed reactor system.

Reciprocating Gas Engine Reactor System

One of the important aspects of advanced reactor design is the recognition of special applications for which a particular type of reactor may be especially well suited. A novel application of a gas-cooled reactor to ship propulsion has been proposed at Oak Ridge. As illustrated in Fig. 2, it involves a reciprocating gas engine, coupled directly to the reactor. The engine is designed for a thermodynamic cycle in which it compresses a gas and delivers it to a reactor where the gas is heated. The hot gas is then returned to the cylinder in which it is expanded to do work. At the end of the expansion stroke the piston uncovers ports in the cylinder walls which permit scavenging of the cylinder by a low-pressure gas loop. The loop includes a cooler and blower to complete the thermodynamic cycle. The cycle is shown schematically in Fig. 2. The argument for a

TABLE III.—*Parameters Selected for KE-ACF Optimum Sized Partially Enriched Helium Cooled Power Reactor*

Active core diameter	Equals 25 ft
Active core height	,, 26·6 ft
Fuel channel coolant diameter	,, 3·6 in
Reactor inlet coolant temperature	,, 430° F (221° C)
Fuel enrichment	,, 2 per cent
Steam generator approach temperature difference	,, 40° F
Steam generator gas pressure drop	,, 2 lb per sq. in
Type of steam cycle	,, dual pressure with reheat

The values of the parameters which were related to the above independent variables in the analysis are given below for the selected optimum GCPR.

Primary coolant pressure	300 lb per sq. in gauge
Lattice pitch	8·8 in
Fuel element burnup	10,000 MWD per tonne
Preliminary Performance Data	
Reactor thermal power (assumed)	600 MW
Blower power (electrical)	18·5 MW
Plant net power (electrical)	223 MW
Reactor coolant outlet temperature	1,050° F (566° C)
Average reactor specific power	6·9 MWD per tonne
Reactor Coolant Flow	2,700,000 lb per hr
Calculated unit power cost	13·3 mills per kWh

TABLE IV.—*Relative Performance of Gases as Reactor Coolants for the Same Gas Temperatures and Reactor Power*

Gas	H_2	He	N_2	Air	CO	CO_2	A
Relative heat transfer coefficient	1·19	1·00	0·73	0·73	0·72	0·79	0·68
Relative pumping power (same channel size but surface temperature allowed to vary)	0·17	1·00	2·2	2·2	2·2	0·88	10
Relative pumping power (channel size varied to hold the same surface temperature)	0·17	1·00	4·0	4·0	4·0	1·8	28
Relative gamma activity	0	0	0·045	1,248	0·5	1·0	137,000
Cost of gas, $ per 1,000 cu. ft (s.t.p.)	6	22·7	10	0	6	5	40

device of this sort has two main points: (1) it can operate with a gas outlet temperature from the reactor 200° F or more below that required with a gas turbine to achieve the same overall thermal efficiency; (2) although having slightly lower efficiency than a steam cycle for the same gas temperature, it requires much less equipment. It is a single fluid system. There is no heat exchange equipment other than the low temperature heat sink. These two advantages hold the promise of low cost per horsepower, low weight per horsepower, and low fuelling costs. Reference to this principle was published in Atomic Review on 3 April.

Nuclear Gas Turbine Ship

A full-scale land-based prototype of a 20,000 s.h.p. nuclear propulsion plant based on the closed-cycle gas turbine system is to be built by General Atomic Division of General Dynamics Corporation under instructions from the USAEC and the US Maritime Administration. The plant will include a gas-cooled graphite moderated reactor, and helium will be the working fluid. The primary loop operating pressure and temperature are to be 800 lb per

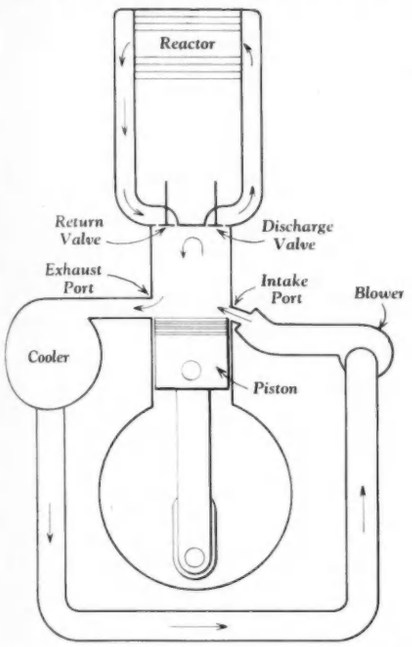


Fig. 2 Circuit for reciprocating nuclear gas engine employing a gas-cooled reactor.

sq. in and 1,300° F (700° C). A basic cycle efficiency of 32·5 per cent is anticipated. The secondary system including heat exchangers and rotating machinery is being designed by the Electric Boat Division of General Dynamics. The rotating machinery is being developed and manufactured by Westinghouse under contract. The present schedule for the Maritime Gas-Cooled Reactor Project (MRGP) calls for initial operation of the prototype early in 1963.

TABLE V.—*Data for 125 MW Pebble Bed Reactor*

Reactor thermal output		337 MW
Electrical power, gross (net)		139 (127) MW
Heat rate, Btu per kWh, gross (net)		8,464 (9,077)
Reactor vessel		13 ft 8 in by 21 in by 5·5 in thick
Reactor core:	equivalent diameter	9 ft
	height	8·1 ft
	voidage	29 per cent
	fixed moderator volume	130 cu. ft
	ball bed volume	383 cu. ft
	breeding ratio	0·477
Reactor blanket:	equivalent thickness	1·33 ft
	voidage	39 per cent
	ball bed volume	496 cu. ft
	breeding ratio	0·353
Fuel elements:	spherical, diameter	1·5 in
	number, core 228,600;	blanket 296,250
Average breeding ratio		0·863
Design power level		350 MW
Design pressure level		1,000 lb per sq. in
Design helium flow		1,360,000 lb per hr
Volumetric heat generation		0·915 MW per cu. ft ball bed
Temperature:	Reactor inlet	550° F (288° C)
	Reactor outlet	1,250° F (677° C)
	Fuel surface	2,170° F (1,188° C)
	Fuel centre	2,440° F (1,338° C)
Cost of power		7·61 to 8·76 mills per kWh

Gas Cooled Reactor for West Germany

A group of 11 West German power companies is expected shortly to place an order for a 15 MW power station with the Brown, Boveri—Krupp group. The plant will be at the North-Rhine Westphalia Atomic Research Centre at Juelich near Cologne. The reactor will be of a new enriched-uranium, graphite-moderated type. This development indicates the desire of West German electric power companies to get experience of nuclear power generation in anticipation of the increased demand for electricity expected over the next 20 years. The reactor is understood to be of pebbled bed design with the helium coolant flowing directly to a gas turbine.

Gaseous Fuel Reactor

The constructional and operational data for an experimental reactor using UF_6 as fissile material have been published in the Soviet Union. The reactor was constructed in order to study the chain reaction in gaseous UF_6, to correct the theoretical calculations, and to carry out research in reactor physics. The first experiments with UF_6 enriched up to 90 per cent with uranium 235 were achieved in August, 1957. Reactor characteristics are: diameter of the active core (beryllium) 116 cm; height of the active core, 108 cm; thickness of the side reflector (graphite), 50 cm; thickness of the upper and lower reflectors, 60 cm; the lattice spacing, 8 cm; the number of rectangular cross section channels, 148; the gas volume in the active core, 213 litres; the beryllium weight in the active core, 1,370 kg; the aluminium weight in the active core, 62·8 kg; the critical mass (uranium 235), 2·024 kg; the critical mass (UF_6 with 90 per cent content uranium 235), 3·340 kg. Experiments show that by selecting favourable conditions it is possible to secure radioactive stability of UF_6 in a reactor. (I. K. Kikoin, V. A. Dmitrievski, *Atomnaya Energiya* (1958)—*Nuclear Science Abstracts.*)

Notes and News

Laying Dreadnought's Keel

The keel of Dreadnought, the Royal Navy's first nuclear propelled submarine, will be laid by H.R.H. the Duke of Edinburgh at the Barrow-in-Furness shipyard of Vickers-Armstrongs (Shipbuilders) Limited on Friday 12 June. The Duke will be accompanied by Viscount Knollys, chairman of Vickers Limited, the Earl of Selkirk, First Lord of the Admiralty, Major-General Sir Charles Dunphie, chairman of Vickers-Armstrongs Limited and Admiral Sir Charles E. Lambe, First Sea Lord. The " keel " to be laid will be a prefabricated section of the vessel. The Dreadnought will have machinery similar to that installed in the United States Navy's latest submarines of the Skipjack class, and is being built by Vickers-Armstrongs, who will also install the propulsion machinery being supplied by the Westinghouse Electric Corporation of America. (Reports on the Dreadnought and her land-based prototype appeared in Atomic Review on 22 May and 24 April when a full list of previous references was published.)

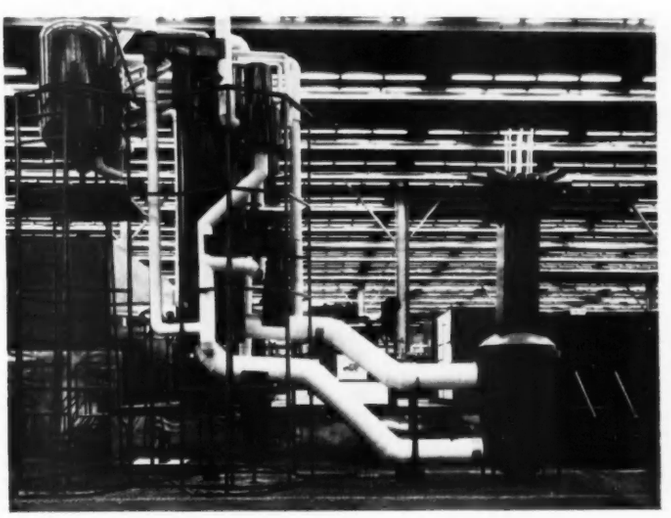


Fig. 3 Model of a portable nuclear power plant developed by Lockheed Aircraft Corporation.

English Electric and Atomics International

An agreement has been signed between the English Electric Company Limited and North American Aviation Incorporated acting through its Atomics International Division providing for collaboration in the development of organic liquid cooled and moderated reactors. The agreement may be viewed in the context of the recent discussion of ship reactor systems (see Atomic Review, 15 May and 22 May) and the association of Atomics International through Interatom with Gesellschaft für Kernenergieverwertung in Schiffbau und Schuffahrt GmbH of Hamburg, on the application of organic moderated reactors to ship propulsion (see Atomic Review 24 April). The Hawker Siddeley Nuclear Power Company have also completed studies of an organic moderated reactor to ship propulsion (Atomic Review 15 May and 22 May).

Nuclear Power Station for Northern Ireland?

Greencastle, Co. Down, according to a recent report, is being surveyed as a site for a £25 million nuclear power station.

Martin Portable Nuclear Plant

The nuclear division of the Martin Company have announced that it has set up a separate department in Baltimore to direct work on PM-1, the portable power plant it is building for the United States Atomic Energy Commission to supply heat and electricity for an Air Force station at Sundance, Wyoming.

Lockheed Portable Power Reactor

A portable nuclear power plant has been designed in America by the Nuclear Products Branch of the Lockheed Aircraft Corporation. If Lockheed's own C-130 Hercules transport aircraft are used, this plant can be crated and freighted in 16 plane loads to any point on earth within 36 hours. The 150 ton kit can be assembled and in operation 90 days after touchdown. It will produce enough electricity for a town of 2,500 people to live and work in the middle of a desert or arctic wastes. Lockheed say a nuclear power plant on very much the same lines as their prepacked unit will be needed when the time comes to colonise the Moon. The plant, which will be available for sale to governments or commercial undertakings, will use enriched uranium fuel. It will be capable of generating 1,000 kW of electricity and 7,000,000 Btu of heat per hour. Twenty men in three shifts could operate the reactor and power plant around the clock. A full-scale model of the power plant, together with control panels, nuclear reactor and supplementary power units is shown in Fig. 3.

PREPARING THE VANGUARD FOR THE 1960's

Tests being carried out now will prepare the Vickers Vanguard turbo-prop airliner for entry into airline service in 1960. It is the "second generation" of a family of short and medium-haul aircraft of which the Viscount was the first. To a significant extent, the family similarity is cutting out much of the trouble which would inevitably be experienced with a completely new design.

British European Airway's first Vanguard airliner taking off for the first time. It is now being tested ready for airline service in 1960.

As orders for the Viscount turbo-prop airliner are passing the 400 mark, Vickers are preparing the Vanguard for the 1960's. The new aircraft is nearly twice the all-up weight of its celebrated predecessor, and to some extent it is destined to become the replacement for the Viscount. But two Viscounts were ordered only a fortnight ago and no doubt other orders will follow. Vickers-Armstrongs (Aircraft) Limited received an order over two years ago from Trans-Canada Air Lines for 20 Vanguards at a time when the design was on the drawing board.

At Weybridge, where the Vanguards are being built, the accepted target is 1 March, 1960, for British European Airways to accept their first machine for operational service. Among airline operators the cheap-fare movement is well under way, hastened by the economical and ubiquitous Viscount, and the Vanguard looks as though it is strategically well timed as the right equipment for the job. Its 139 economy-class seats will give the traveller cheap transport and the operator a substantial profit. New mass travel markets are envisaged in the 1960's, as air travel comes down in cost and attracts a broader based market. A similar development may take place with freight transport; if it does, the Vanguard is already well adapted to the work. In spite of its size it can operate to a very high proportion of, for example, European and Mediterranean aerodromes. Vickers believe that cheap fares, made possible by improved aircraft design, are more important to the passenger and operator than a couple of minutes off a journey time.

The first three Vanguards are being instrumented for extensive flight tests. The first machine will continue to be used by Vickers, but the second is already finished in BEA colours and will, in fact, be their first Vanguard to go into service. Nos. 1 and 2 have been completely instrumented; No. 3 will be instrumented for tropical trials only; and No. 4 will be used for route proving. No. 2 has already been used for general survey work, and propeller strain-gauge tests have been carried out on the two propellers on one side of the aircraft. The company plan to do flight resonance tests and also 50 hours of handling tests on No. 1 and on No. 2. Tropical tests with No. 3 will be undertaken at Khartoum for low level conditions and later this year at Johannesburg for high level. About 150 hours will be devoted to tropical trials, which will include the Rolls-Royce Tyne turbo-propeller engines. At the other end of the climatic scale, "winterisation" trials will be carried out with the 4th machine in Canada. The experience gained by TCA in the winter operation of the Viscount will count for much in avoiding snags with the Vanguard and in generally creating confidence in the ability of the machine to operate in those conditions. Napier de-icing mats are being used on the tail plane and fin, and tests have already been carried out up to 27,000 ft (the nominal operational ceiling is 30,000 ft).

Since the first aircraft made its maiden flight on 20 January this year, it had completed 119 hours up to Sunday, 24 May, and the second aircraft had completed 37 hours. The planned average rate of testing at one hour a day is now being comfortably maintained. In all, the certification programme will involve nearly 1,500 hours' flying by five aircraft. The 3rd, 4th and 5th Vanguards are now on the final assembly line at Weybridge.

The first three Vanguards all contain comprehensive test instrumentation and automatic observation systems, enabling a wide range of performance, handling and engineering data to be obtained simultaneously. Each hour of flight testing is therefore made as productive as possible.

Performance tests to date are reported to have shown satisfactory results. The first aircraft has already demonstrated a cruise speed of 425 m.p.h., T.A.S. at 25,000 ft. This will be the normal recommended cruise speed of the Vanguard as now built, powered by Rolls-Royce Tyne 11 engines. Test results so far suggest that the guaranteed performance will be exceeded.

Most of the flying to date has been at the lower end of the speed range. Experience of higher indicated airspeeds will be built up during the next phase of the test programme, following the installation of flight resonance gear in No. 1 machine. To enable this gear to be fitted the aircraft ceases flying for about three weeks, and while it is in the hangar a new dorsal fin of increased area has been fitted. This is required to give optimum handling under the most severe straight sideslip conditions. A full inspection of the aircraft is also being carried out during this period.

An intensive test programme has exposed the Vanguard to "airline" conditions rather earlier in its life than is usual with a new aircraft. One landing within a few weeks of the first flight was made on a wet runway with a crosswind of 20 knots steady, and during the same period several low visibility instrument approaches were made. Pilots reported that the Vanguard is "a pleasant aircraft to land" in such conditions. The Vanguard's first landing away from home base was made on 9 April at Bournemouth (Hurn) Airport for the purpose of assessing the aircraft's night lighting systems. Only minor improvements were requested as a result of these trials. Pilots commented that at 20 ft above the runway the wing and nose landing lights produced a daytime effect.

The instrumentation is largely by photographic recording, with trace recorders for most of the vibration tests and a limited use of magnetic tape. In the United States the complete automation of flight test recording by magnetic tape provides such remarkable quantities of data as 3 million items in a two-hour flight, compared with about 15,000 measurements for a one-hour flight such as is carried out on the Vanguard. There appear to be at least two disadvantages

Front fuselage unit in proof pressurisation testing tank.

Special Article

of the complete magnetic tape method—the very high cost, which has to be paid for, and the delay of at least 48 hours before the computer deciphers the magnetic record and anyone has the slightest idea of any suspicious performance. The total time required for the test programme appears to be no different for the Vanguard than for an equivalent American aircraft.

A Vickers' test pilot, Captain R. Rymer, describes the Vanguard's flight deck as "a good office"—brief cases, teacups, and other miscellaneous stores are conveniently stowed! The floor is flat, so there are no steps to trap dropped pencils and the like. These may seem to be small points, but in fact they are quite important to pilots who operate on short and medium routes where there is hardly a moment to spare in the flight. The main Triplex cockpit window is said to be the largest that can be made for such a pressurised aircraft. "All kinds of adjustments" are built into the cockpit. Each pilot has a complete blind flying panel to himself. The radio controls have been placed on the pedestal between them to ease the job of flying in complicated control zones. On the pedestal also there are two sets of throttles, one for each pilot.

Captain Rymer said that the Vanguard flies exactly like the Viscount (especially the later marks). It is better in the pitching plane, but at first was not so good in the yawing plane; a dorsal fin is now being added. He said, also, that from the mock-up stage, pilots of the Air Registration Board had been familiar with most of the details which they would eventually have to approve. There has been some trouble with the nose-wheel steering, but this has now been overcome. It is now possible to "make the nose do all you want it to." Some work has been done on approaches to stall, though the company have not yet embarked on a true stalling programme. Captain Rymer remarked that the flight deck is very quiet, and in terms of interior and exterior noise the Vanguard is expected to be at least as good as the Viscount. Precise measurements of noise levels must await completion of the fourth aircraft, which will be the first to be fully furnished.

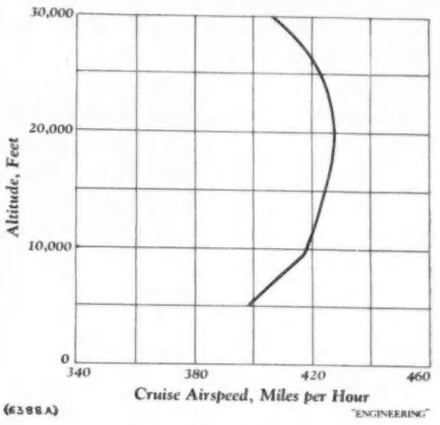
The illustrations reproduced here bring out some of the points which have been mentioned. The Vanguard front fuselage shown in the proof pressurisation testing tank represents a complete fuselage containing specimens of all the cut-outs that are found in the pressure hull. A similar specimen was used for fatigue pressurisation tests in the Weybridge stratosphere chamber, where representative conditions of temperature and pressure can be simulated. The electrically heated windscreen panels were cycled.

The main undercarriage units are shown under test. They are being cycled less than every two minutes for about a year. Some of the test instrumentation is shown in another photograph. A wooden false floor is used to carry the automatic observers. The one shown in the foreground is used to record power generation, load frequency stability, number of operations of actuators and motors and hours run, together with operating currents and voltages.

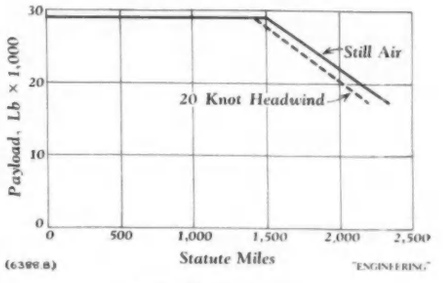
Behind the electrics panels is the air conditioning and de-icing panel which records operating temperatures and pressures throughout the system. The large crate in the centre background contains (top) the handling panel, which records true airspeed, true altitude and attitude, control surface angles and loads. Below it is the "essentials" panel providing such key information as torquemeter readings, compressor r.p.m., speed, height and temperature, which are required when evaluating any other part of the aircraft systems. Observer No. 6 (left background) is the engine bay cooling and electrical cooling panel, which records pressures, temperatures and flows.

The typical cruise performance graph relates to a standard day, 500 mile sector, 60 per cent load factor. It shows that the Vanguard has a cruise speed of 420 m.p.h. or better over a wide altitude band of from 11,000 ft to 26,000 ft, making for accurate scheduling whatever the air traffic control restrictions. The payload range curve relates to cruise at constant altitude and allowing a two hour reserve. It signifies that with 84 economy-class passengers and four tons of freight, the Vanguard's range, with reserves, is 1,750 miles. The full-tank capacity range with 86 passengers is 2,340 miles. Further developments are likely to take place in range and payload. In the curve of "break-even" need against miles, a passenger revenue rate of 8 cents per seat-mile is assumed.

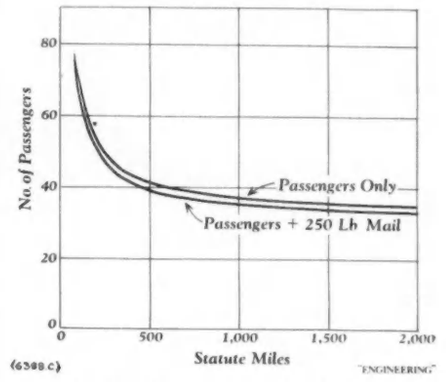
The company's airfield at Wisley, from which the test flying is carried out, has been equipped with a Decca 10 cm MR100 radar which enables test flying to be carried out safely in spite of the nearness to one of the world's busiest civil control areas (London Airport). There is an added complication in that the approaches to Wisley pass over the Farnborough military approach pattern. With the Decca radar, which is now in full operational service, gap-free coverage is provided to at least a height of 40,000 ft (in normal airline service the Vanguard would not go much above 20,000 ft) and a range of 100 miles—these are the figures for a small fighter aircraft but they would be higher in the case of such a large machine as the Vanguard civil airliner.



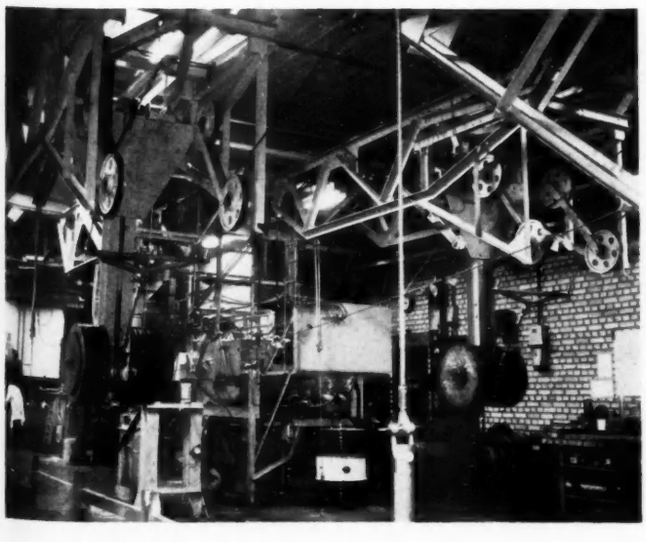
Typical cruise performance.



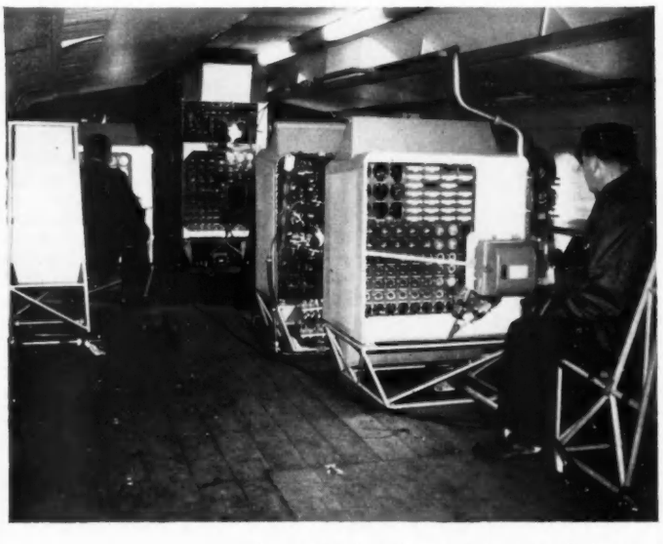
Payload-range curve.



Number of passengers to break even.

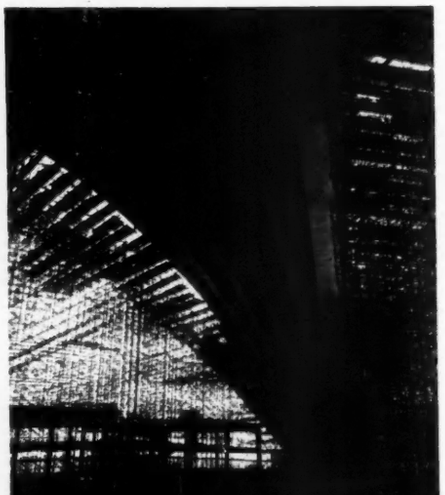


Hydraulic landing gear test rig.



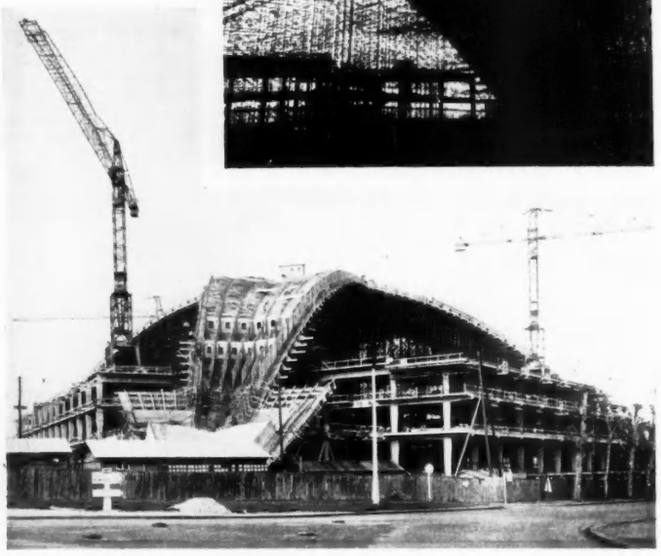
Automatic observing equipment for flight tests.

LARGE SPAN VAULTED ROOF IN SHELL CONCRETE



(Right) The tubular scaffolding supporting one of the three sections forming the roof to the new Paris exhibition hall.

(Below) Exterior of the hall, during construction showing the great arch openings along each side of the site.



The new exhibition hall of the *Centre National des Industries et Techniques* in Paris, just beyond the Pont de Neuilly, is built wholly of reinforced and prestressed concrete. In plan it is an equilateral triangle with sides 738 ft long. The crown of the roof is 150 ft above ground level.

The main roof comprises three double shells in fan-shaped sections, designed as groined vaults with great arch openings spanning the full length of each side of the building. Each section is made up of 18 "corrugations" that grow out of the corner abutments, each "corrugation" comprising a top and bottom shell joined along their edges by 2½ in thick precast concrete webs and separated by membranes at about 30 ft centres. Each shell is 2⅜ in thick near the crown, 2¼ in thick at the main section and nearly 24 in thick at the abutment; the top and bottom shells are 6 ft apart at the crown and 9 ft at the abutments. The superficial area of each section is 75,000 sq. ft. At the junctions between the sections, the webs are replaced by "crown walls" comprising heavy I-beams, 12 ft deep, with 11 in webs and flanges 15 in thick which vary from 2 ft to 4 ft in width.

This massive roof covers a main exhibition floor at first storey level of 220,000 sq. ft, with another of 270,000 sq. ft below it; there are also galleries and ancillary rooms such as offices, restaurants and cloakrooms. Along one side there is a monumental staircase, as well as a long angled ramp for lorries, leading to the main floor, which is carried on fluted columns, 33 ft high and 32 in in diameter at the base. In section these columns are roughly hexagonal with concave faces, and they were cast in a single lift in formwork built from six vertical cylinders.

Three major French civil engineering contractors, Balency and Schuhl, Boussiron, and Coignet have collaborated in building the hall. Several eminent engineers, including Nerni and Freyssinnet, prepared structural schemes for the roof but that finally selected was evolved by M. Nicholas Esquillan, technical director of Enterprises Boussiron. The construction period allowed was 21 months, including preparation of the foundations.

To meet the structural requirements of the roof a particular dry mix concrete was used (to give 17,000 lb per sq. in) and to place the concrete in the shells a high-frequency low-amplitude vibrator was used in conjunction with a light float for surface tamping. This equipment has been developed by Vibratechniques of Paris (and available in the United Kingdom and Commonwealth under the trade name of Sinex Turbo Vibrators (STV) distributed by Holman Brothers Limited, Camborne). The roof was concreted in bays, each supported by a close system of tubular scaffolding. All the concrete was mixed in a central batch-weighing plant located 2½ miles from the site. Watertightness of the roof has been obtained with the dense compaction of

(Continued on next page)

TEMPLE MILLS MARSHALLING YARDS

The Eastern Region of British Railways have brought into use their rebuilt Temple Mills marshalling yard, outside east London. Yards have existed there since 1880 and have been added to piecemeal ever since until finally there were ten marshalling yards in the area each serving a limited number of stations and routes. This arrangement made a great deal of trip work necessary and wagons were often shunted several times before they left for their destinations.

The new Temple Mills, a single integrated yard, will eliminate much of this repeated marshalling, and the higher shunting capacity has enabled five periphery yards to be closed down. Six old signal boxes have been replaced by three new ones. The new equipment has increased the rate of shunting and cut the number of shunting movements, to give a much improved throughput.

Temple Mills New Yard was authorised in February, 1954, and construction started later the same year. As freight services had to be maintained work was undertaken in a number of stages that enabled reconstructed sidings to take shape as the old disappeared. At one time, following the demolition of two old signal boxes, movements in the yard area took place under hand signals.

The new yard is a hump yard with twelve reception sidings, seven of which can receive traffic from both ends. There are also 49 double-ended sorting sidings in eight groups and eight principal departure yards. In addition, there are a number of subsidiary yards for sorting and servicing. A new feature of the layout is a reversing spur for humping engines beyond the crown of the hump, which allows two engines to work in conjunction with the minimum of delay. In all there are 52 miles of track in the yard.

In order to accommodate the new yard, the greater part of an existing wagon works has been resited and the main running lines have been diverted around the periphery of the yard. Alterations have been made to Lea Bridge station and some bridge reconstructions. New buildings include, apart from the three signal boxes, a yardmaster's office, a central control tower (also incorporating a substation and compressor house), the hump cabin and numerous ancillary buildings.

For operation purposes an extensive signalling system has had to be installed and, in addition, two groups of wagon retarders have been fitted. The system employed uses electro-pneumatic units with route control of points in conjunction with automatic route storage. Each group comprises one primary and four secondary retarders, and each secondary unit serves six classification sidings arranged on the balloon principle. Lighting is provided by colour-corrected mercury vapour lamps mounted 55 ft above ground level.

The earthworks and track laying were carried out under the direct supervision of the district engineer, Stratford, with additional labour from Tersons Limited.

Primary retarder—for slowing down wagons.

the concrete and a thin cement rendering; to ensure complete water-tightness, however, the roof has been given a coating of a light coloured polyester-based paint.

The roof is believed to contain the longest span yet built as a thin shell vaulted structure and the three sections are the largest surfaces supported at a single point.

HANDLING LONG WELDED RAILS

London Transport have evolved a simple carrying device or "thimble" which, slung from a crane hook, enables long welded rails to be installed rapidly by a small labour force. Laying speeds of up to two miles of single rail an hour are possible.

The device, shown in the illustration, consists of two 2½ in diameter rollers, each 9 in in length mounted at 10 in centres in roller races between side plates. The side plates are ¾ in thick and 15 in by 17 in wide at the base, and are kept apart by distance pieces. The swivel eye is fixed to a floating block which lips under two 1 in diameter pins.

The rails to be laid are shop-welded into 300 ft lengths at the yard and off-loaded into the "four-foot" from rail-carrying trains. Rails are then site welded into lengths of usually ¼ mile. With the new method of installation the end of the rail is jacked up and the thimble threaded on it. The crane, which may operate from the adjacent track if running rails are being handled, travels slowly forward while three men bar the slung rail into the conductors or chairs.

To guard against breakdown, the thimble is designed so that it can be quickly detached from the rail by drawing the gib keys and removing the 1 in pins.

Long welded running rails were pioneered in Britain by London Transport, who first used them in 1936. At their permanent way depot at Lillie Bridge 300 ft lengths of rail are made up from five rails 60 ft long flash butt welded together. These 300 ft rails are then taken to the site on special rail trains and nine such rails are joined together *in situ* by special fishplates to make an unbroken length of just over half a mile. Expansion switches are installed between each half-mile length.

Wherever possible, new track in tube or in surface lines laid on London Transport railways since 1938 has been long welded and today a third of the system is of welded rails. For various reasons, particularly curvature, they are not suitable for use everywhere on the Underground system. Current rails, also in 300 ft welded lengths, are also used and these are welded on site into half-mile lengths.

Fatigue in Engineering Structures

Fatigue in structures is to be reviewed by a committee set up by the Department of Industrial and Scientific Research, following an approach from the Institution of Civil Engineers. The official announcement says that the review will not be concerned with aircraft structures, reinforced concrete structures or metal physics, though information gained in these fields will be used; indeed, some members of the committee have particular experience in these excluded fields.

The terms of reference for the committee are "to review current research needs on fatigue of engineering structures (metal), to survey existing research facilities and to make recommendations . . ." The committee are going to examine records of failures or accidents which might have been due to structural fatigue, even though fatigue was not recognised as the initial cause.

Professor Sir Alfred Pugsley, F.R.S., of the Department of Civil Engineering at Bristol University and a past-President of the Institution of Structural Engineers, has been appointed chairman. The other members of the committee are Sir Donald Bailey (Military Engineering Experimental Establishment, Christchurch), Mr. T. Baldwin (B.T.C., Research Division, Derby), Mr. H. L. Cox (Basic Physics, NPL), Mr. O. A. Kerensky (Freeman, Fox and Partners), Mr. H. N. Pemberton (Lloyd's Register of Shipping), Mr. C. E. Phillips (NEL, East Kilbride), Professor S. C. Redshaw (Department of Civil Engineering, Birmingham University), Dr. P. B. Walker (RAE, Farnborough), and Dr. R. Weck (British Welding Research Association). Fundamental knowledge and acquaintance with experimental techniques is thus nicely balanced against industrial experience, and the committee is well based to consider problems over a wide range of structural forms. It would seem that there are two major fields for survey by the committee: loading patterns encountered, particularly the frequency of high loads, and the strength of connections, especially where a high degree of rigidity is developed.

Mont Blanc Road Tunnel

Work has begun on driving the Mont Blanc road tunnel from the French side. Work from the Italian side began some months ago and the tunnel has been pushed forward 650 yards. A description of the tunnel and some notes on the Italian workings were given in our issue of 17, April page 494.

Auckland Harbour Bridge Opened

Auckland Harbour Bridge was formally opened to traffic on 30 May. It is a toll bridge, designed by Freeman, Fox and Partners of London and built by a consortium consisting of the Cleveland Bridge and Engineering Company and Dorman Long and Company. In association with the bridge, extensive approach roads have been constructed.

Major Dam in Saskatchewan

Work has been begun on the South Saskatchewan river dam which is expected to cost $184 million and to take between six and ten years to complete. When finished the dam will be 3 miles long and 200 ft high, impounding 8 million acre-ft of water. Irrigation will be provided in an area of dry farming on marginal ground for an initial 50,000 acres and eventually for 500,000 acres. Doubt has been expressed—and held up the start of work for nearly 100 years—that the capital cost can never be matched by the possible returns. Most of the cost is being borne by the Federal Government. The provincial government, who are finding about a quarter of the cost of the dam and all that for irrigation and power installations, believe that the best prospect lies with forage crops, beef cattle and dairy heads on the improved land.

Wind Pressure Map of USA

The National Bureau of Standards Building Materials and Structures Report, No. 152, *Wind Pressures in Various Areas of the United States*, is now obtainable, price 15 cents (plus postage), from the Government Printing Office, Washington 25, D.C.

The publication gives a step by step description of the procedures used to make the map, and a table showing how the pressure increases with height above ground. Emphasis is placed on methods used to calculate pressures from recorded wind speeds; other factors contributing to a minimum design wind pressure that are discussed include effect of gusts, variation of wind pressure with altitude, distance from sea-coast, topography, and the frequency of various types of storm.

CEGB Contracts Placed

The Central Electricity Generating Board have placed contracts during the last month for power stations, transmission lines and transformer stations amounting to £13½ million. The contracts at power stations for civil engineering work include:—

Belvedere: structural steelwork for southern section, Sir Wm. Arrol and Company Limited.

Blyth B: Foundations and civil work, Sir Robert McAlpine and Sons (North Eastern) Limited.

Skelton Grange B: Superstructure, J. L. Keir and Company Limited.

Padiham B: Two natural draught cooling towers, Mitchell Construction Company Limited.

Laminated Timber for Prefabricated Shed

The largest waterproof laminated plywood sheets yet seen in the United Kingdom are part of a prefabricated timber drying shed shipped in the P and O cargo liner Ballarat which arrived at Grangemouth at the end of May.

The sheets, made under the trade name of Breswood, are 25 ft long by 7 ft 6 in wide in one piece without jointing. The shed was ordered by W. I. Brine and Sons of Edinburgh from the Australian firm of Ralph Symonds Limited. When built, the shed will be 100 ft long by 50 ft wide and will be constructed of five hollow-core laminated arches, laminated beams, purlins and Breswood sheets.

Road Materials Courses

Lecture courses on road materials and construction will be held at the Road Research Laboratory, Harmondsworth, during the autumn and winter of 1959. As in the previous years, they will deal with the fundamental properties of the materials and of applications in modern practice. Courses will be held as follow:

Concrete—29 September to 8 October, and 13 October to 22 October.

Bitumen (including tar)—26 October to 6 November, and 9 November to 20 November.

Soil Mechanics—24 November to 1 December, and 8 December to 15 December.

A three-day extension to the courses on soil mechanics will deal with problems met in the tropics.

The fee for each course is £12 10*s*; those attending will have to make their own arrangements for accommodation. Forms of application (returnable by 10 July) are obtainable from the Director, Road Research Laboratory, Harmondsworth, Middlesex.

By Gordon Wilkins

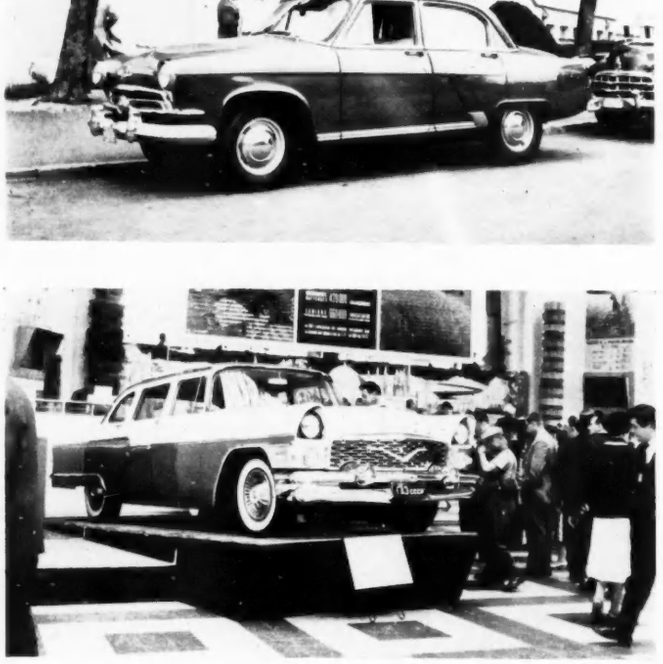
RUSSIAN MOTOR INDUSTRY DISCOVERS THE CONSUMER

The trade agreement between Britain and Soviet Russia has produced an outbreak of interest in Russian cars, but it seems unlikely that those at present available will prove more attractive here than they have been in Belgium and Switzerland, where they have been rejected by the retail trade as heavy, prone to rattle and excessively expensive in relation to comparable Western models.

The Russian industry is in a transition period and is having to change its methods and its products following the discovery of the consumer as a person whose desires and preferences have to be considered. Until recently the only models which remotely resembled popular cars were the Moskvitch, derived from the pre-war Opel Kadet, tooling for which was removed from Germany to Moscow; and the Pobieda, a Russian design which is still built in Poland as the Warszawa. The Moskvitch was recently given a new roomier body and for 1959 the 1,220 cc side valve model is supplemented by one with an overhead valve pushrod engine of conventional design giving 45 b.h.p. at 4,500 r.p.m. on a 7 to 1 compression ratio.

(Right) Moskvitch 1957 model. Later ones have more chromium.

(Lower right) New baby car, the Communard, has a 25 b.h.p. engine.



(Above left) 1957 model Volga.

(Left) 1959 prototype Tschaika.

The Pobieda is sometimes likened to the first post-war Standard Vanguard, but the Russian model was the first to appear. It was notable for its side-valve four-cylinder engine with four-bearing crankshaft, delivering 50 b.h.p. at 3,600 r.p.m. from 2,120 cc on a compression ratio of 6·2 to 1, but in a car weighing nearly 3,000 lb the performance was far from brilliant.

Compression ratios are generally low in Russian production, because of the low octane rating of available fuel but higher compressions are being offered for export on the new models. Dashboard controlled radiator shutters are a normal feature of Russian production and comprehensive toolkits are provided as garages are few and far between.

Moscow, where the Moskvitch is built, and Gorky, which produces the Volga, are the two centres of passenger car production. Since the war, car works have also been built at Kutaissi and Ulyanovsk and the Moscow works has been modernised. Only a little over 20 per cent of vehicles in use are passenger cars, but the proportion is rising.

During the ten post-war years when the Moskvitch, the Pobieda and the big ZIS (copied from the Packard) continued in production unchanged, Soviet propaganda proclaimed that their engineers, being insulated from wasteful capitalist competition, were not obliged to make frequent changes of style: but all that has changed. Artificial dual colour schemes, marked out by irrelevant applique chromium decoration, ape the worst excesses of the West and in the three years of its existence, the Volga, which replaced the Pobieda, has had three different radiator grilles.

The Volga is a solidly built five-seater four-door sedan with a four-cylinder o.h.v. "square" engine of 2,440 cc (92 by 92 mm). For 1959 compression has been raised to 7·5 and it delivers 80 b.h.p. at 4,000 r.p.m. Originally it had a three-speed gearbox with steering column lever but is now offered with a torque converter and three-speed planetary transmission.

The engine reflects the growing Russian effort to reduce weight by liberal use of aluminium. Cylinder head, block, valve cover, pistons and valve guides are made of light alloy and the crankshaft is a hollow shell iron casting. Even so, the dry weight is about 3,000 lb.

The Zim six-light four-door limousine, which is widely used by Russian embassy staffs throughout the world, was an original post-war Russian design, completely conventional in conception, with six-cylinder o.h.v. engine producing 90 b.h.p. at 3,600 r.p.m. from 3,480 cc. It is soon to be replaced by a new model based on the Tschaika prototype shown at the Brussels Exhibition last year. This has a V8 engine of 4,890 cc with aluminium block and heads. It is said to weigh scarcely any more than the cast iron engine of the Zim, but produces exactly twice the power. The automatic transmission, by torque converter and planetary gearbox, also has an aluminium casing. The car itself is in flamboyant American style with steel panelled body on a cross-braced chassis of conventional design. It has servo-assisted steering and braking, with handbrake acting on the transmission shaft. Dry weight is 3,960 lb.

The largest Soviet car, the ZIS, is being replaced by the ZIL III, which closely resembles the last of the Packards in style and has a V8 engine of 5,980 cc giving 220 b.h.p. at 4,200 r.p.m.

However, the prospects for Russian cars on the international market may well be improved if they choose to sell their new baby car, the Communard, at a competitive price. The designers appear to have played safe by adopting the major mechanical features of two successful Western models, the Volkswagen and the Fiat 600.

WHERE TRANSISTORS STAND TODAY

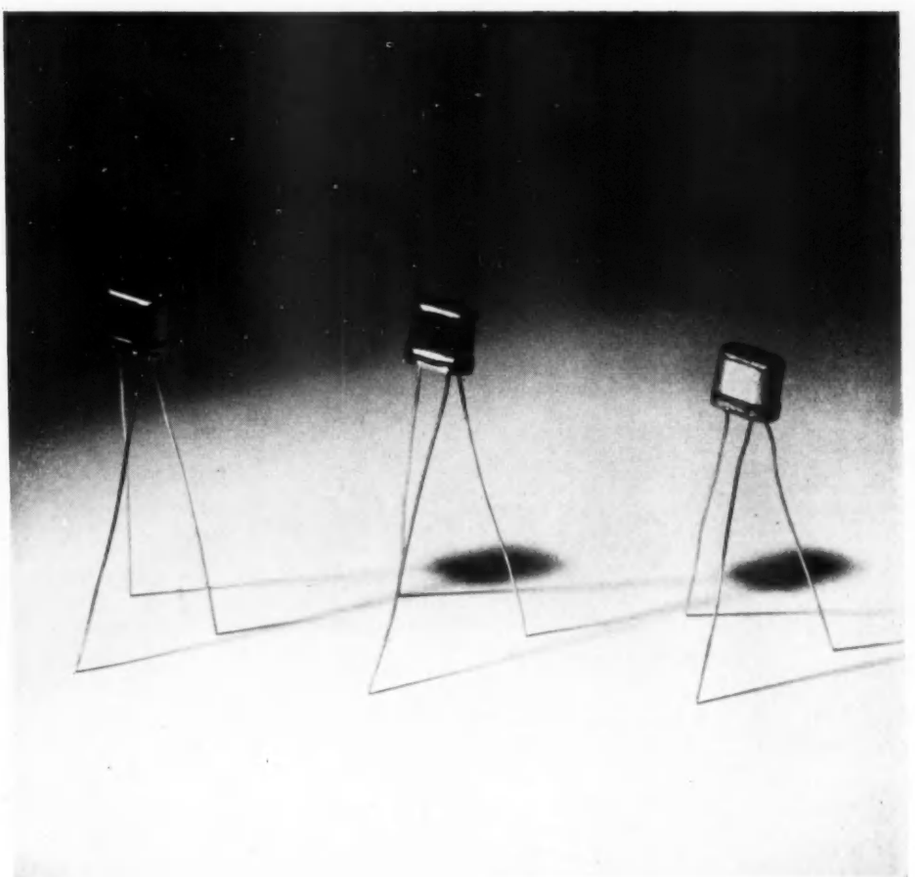
and other Semiconductor Devices

"An amazingly simple device, capable of performing efficiently nearly all the functions of a thermionic vacuum tube. . . . Known as the transistor, the device works on an entirely new physical principle discovered by the Laboratories in the course of fundamental research into the electrical properties of solids." This is an extract from the news release given by the Bell Telephone Laboratories, where the transistor was invented, almost 11 years ago.

Since then, in a little more than one decade, this small device has grown from little more than a scientific curiosity into a whole new industry—one that is adding significantly to the progress of electrical engineering and, by so doing, is becoming the prime mover of a number of advances in the field of engineering as a whole.

The progress of these devices has occurred so rapidly in recent years, and in so many different places, that the problem has arisen of exchanging information on an international basis. For this reason, the Institution of Electrical Engineers promoted the International Convention of Transistors and Associated Semiconductor Devices and the International Transistor Exhibition, both of which were held at Earls Court, London, from 21 to 27 May. The convention brought together some 1,850 international delegates, including the Nobel Prize winning inventors of the transistor, Professor J. Bardeen, Dr. W. M. Brattain and Dr. W. B. Shockley. Some 150 papers and lectures were presented, dealing with recent developments in basic theory, measurements of characteristics, applications and manufacturing techniques.

The success of these combined events, the convention and the exhibition, might be said to have formed a milestone in the development of a new industry; one which has marked its maturity and given it official status as an engineering entity. At the same time they have sparked off a renewed and more vigorous general interest in the technology of semiconducting devices.



A group of switching transistors.

The Transistor

In his opening address at the Convention, Viscount Hailsham is said to have remarked: "I do not suppose that one person in ten thousand, even in the most industrialised countries, could explain what a transistor is, or even a semiconductor."

"Eleven years ago no one could have said, because transistors did not exist. Yet they now play an integral part in our lives, from the satellites and space vehicles which revolve around our planet or probe toward the moon o the humble hearing aids which assist the deaf towards a fuller and therefore a happier life. For the transistor is, I am confidently assured, the most significant development in electronics since the invention in 1904 of the thermionic valve."

It was certainly not an overstatement to rank the invention of the transistor with that of the vacuum valve. It is also probably true that few people (engineers included) could ably explain what a transistor is; after all, one decade is not much in terms of engineering history and the transistor is only one of many hundreds of engineering developments that have occurred during that time.

However, the transistor has now shown itself to be one of those rare devices which, like the vacuum valve, will have far reaching effects on many branches of engineering other than that from which it was evolved. For this reason, this article has been written as a general and simplified introduction to the principles of the transistor, a summary of its present-day applications and a guide to the possible applications of the future.

Briefly, the transistor is an electronic device which makes use of the physical properties of semiconducting materials to form a circuit element having the ability to oscillate and amplify small electrical signals. But what are semiconducting materials? Well, to begin with, they are materials which have electrical conductivities ranging between those of metals and insulators. That is to say, they are semiconductors of electrical current. The most important of these materials, as far as transistors are concerned, are germanium and silicon, both of which are from group IV of the periodic table. Germanium has been the most widely used so far, although the thermal properties of silicon have led to an increase in its use since germanium tends to become a conductor at relatively low temperatures, thus restricting its range of applications.

The germanium atom has four electrons in its outer shell, that is, four valence electrons. In a pure crystal of germanium these electrons link up with those of neighbouring atoms to form what is known as a covalent bond (see Fig. 1). This makes the crystal a perfect insulator, since there is no tendency for electrons to be induced into or out of the material. However, if small traces of a suitable impurity are present, having either more or less than four valence electrons, the perfect bond no longer exists throughout the crystal structure, and there will either be some free electrons or a deficiency of electrons, either of which will allow a limited current to flow. Thus, by introducing the right type of impurity, e.g. indium (three valence electrons) which leaves an electron deficiency in the crystal, or arsenic (five valance electrons) giving an electron surplus, two types of semiconducting material may be produced (see Figs. 3 and 4). The former type (electron deficient) is known as a "p-type," because it is considered as a positive "hole" carrier and the latter type is known as "n-type," because it has negative carriers (free electrons).

The conducting action of an n-type semiconductor, under the influence of an electric field, is much the same as that of a metal, but with higher resistance to flow. However, the action of the p-type is more subtle. The usual way to describe this action (although it is not strictly correct) is to say that electrons "jump" into the vacancies (holes) of the impurity atoms, always going in the direction of the positive force, resulting in a migration of positive holes toward the negative force (see Fig. 4). If an n-type material

is formed into a junction with a p-type, an electric field is formed at the boundary—this is the phenomenon which enables these materials to act as amplifying devices. The direction of this field, known as the barrier field, tends to inhibit the flow of both electrons and holes across the junction. However, if a voltage is applied to this junction so as to oppose this field, current flow may take place. A simple junction of this type may be used to rectify alternating current, since the voltage in one direction will overcome the barrier and allow current to flow, while the voltage in the other direction will add to the barrier field and inhibit current flow still more.

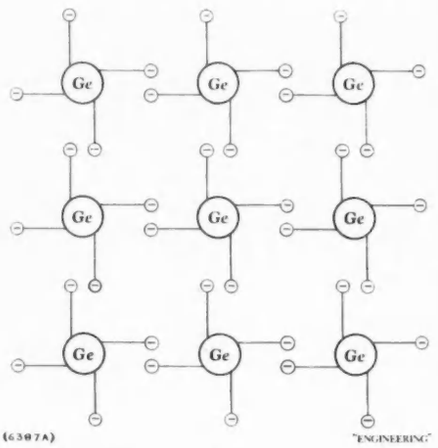


Fig. 1 Structure of pure germanium crystal.

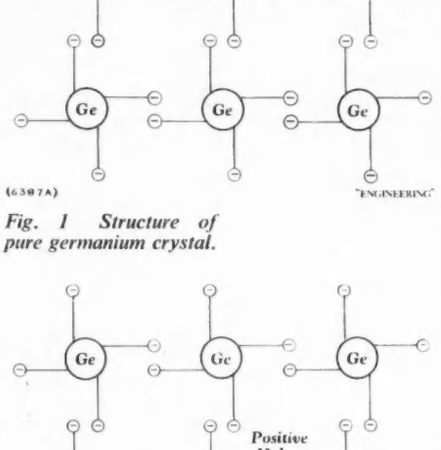


Fig. 2 Structure of germanium crystal with indium impurity added—showing how a " positive hole " is formed.

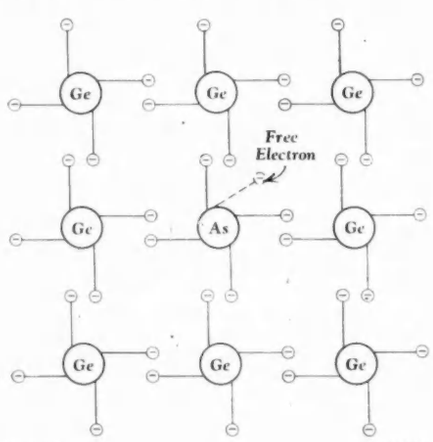


Fig. 3 Structure of germanium crystal with arsenic impurity added—showing how free electron is formed.

The transistor goes one stage further than the simple two stage junction rectifier. A thin layer of p-type material is sandwiched between two thicker layers of n-type material to form what is known as an n-p-n junction transistor (p-n-p types also exist and are fundamentally the same). The central layer is called the base and is analogous to the grid of a vacuum valve. The material on the input side is called the emitter (similar to the cathode of the vacuum valve) and the material on the output side is called the collector (like the anode of the vacuum valve).

These three " electrodes " may be connected as shown in Fig. 5, the emitter being biased to overcome its barrier field and the collector being biased to assist its barrier field. These voltage connections allow the emitter to pass electrons into the base but prevent the collector from doing the same. However, the collector, which is positive, will attract any electrons which enter the base from the emitter, thus allowing a current to flow into the output circuit. If the signal current varies, so will the collector current, thereby producing an action similar to that of a thermionic valve. The current in the collector may only be the same as that in the emitter, but due to the high impedance of the collector junction, greater output energy may be handled there, resulting in power amplification.

Thus we have an analogy between the vacuum valve and the transistor in that the transistor can effectively enlarge small electrical signals. Although the junction transistor described here is the most widely used at present, it is rapidly being superseded by ones produced by new techniques of construction, particularly alloy diffusion.

Its Applications

An analogy between the valve and the transistor can be drawn to illustrate what the transistor can do, but beyond that the similarities end. Not only are the physical principles different but there are many relative advantages and disadvantages, the balance of favour tending to fall more on the side of the transistor as its development progresses. The main advantages of the transistor are its size (many times smaller than an equivalent valve), its low power requirements, its low voltage requirements, its low heat output and its mechanical ruggedness.

These combined features have made it possible to reduce the size and weight, and increase the reliability, of many types of electronic equipment to a remarkable degree. During the past five years a great deal of communications, navigation and control equipment used in aircraft has been reduced in size by at least a factor of five. The reduction in space has been even greater in equipment for use in guided missiles and artificial satellites. Further reductions, of the order of 10 to 100 times seem possible in the light of new circuit concepts that are now being evolved.

For the flight testing of aircraft, new transistorised equipments are today being used which could not have been carried in aircraft a few years ago. One such equipment, developed in the United Kingdom, contains 90 transistors in a unit weighing only 3½ lb.

In radio communications and telephone equipment, in computers, nucleonic equipment, industrial measuring and control apparatus and electro-medical apparatus, the transistor is also finding an increasingly wide range of applications. Portable radiation monitors have already gone over largely to transistors and transistors are now being used in most of the newer designs of digital computer. Computer installations which at present require a large room are likely, in a few years time, to be no larger than an office desk or filing cabinet.

Another field of application which will demand large quantities of transistors and other semiconductor devices, is the electronic telephone exchange. Transistorised telephone switching systems require less than one quarter of the floor space of the conventional electromechanical systems and the speed of switching can be increased a thousandfold.

As the reliability is improved to the point where transistors give consistent performance for 20 years or more, they will also be in great demand for use in further transoceanic telephone cable installations. By using the newer types of high frequency transistor now being developed, it should be possible to handle hundreds of telephone conversations on a single cable.

Semiconductor Diodes

In addition to transistors, during the past 11 years a large range of semiconductor diodes and rectifiers has been developed. These are essentially two terminal devices which have the property of passing current in one direction only, as previously mentioned. They can be broadly divided into signal diodes, microwave mixer and detector diodes, zener or reference diodes and power rectifiers. Germanium point contact diodes, which are low current rectifiers, are extensively used as detectors, interference suppressors and mixers in radio and television receivers. Silicon point contact diodes are mostly used as microwave mixers in radar equipment.

The scope of these devices has been greatly extended since the advent of junction formations, which have largely superseded the point contact technique. By forming a junction between two different types of semiconducting materials in a similar manner to the junction transistor, the current carrying limitations of the point contact have been largely overcome. The current carrying capacity of these devices is now of the order of several hundred amperes per square centimetre of junction area, and electrical efficiencies of well over 90 per cent are possible. Germanium devices of this kind are largely used in low voltage high current supplies.

Small junction diodes find extensive use in power packs, and the larger ones are to some extent replacing selenium and copper oxide rectifiers in battery charging and other power rectifying units. By suitably connecting diodes in series or parallel, their power handling capacity may be sufficient to operate traction equipment. Semiconducting rectifiers are becoming increasingly used for electroplating, electrolysis and numerous other industrial processes demanding large direct current supplies.

Zener diode is the name given to semiconductor voltage regulators, stabilisers and reference diodes. They have a well defined voltage breakdown region and are therefore similar in nature to neon and other gas filled stabilising tubes. Zener diodes are now widely used as reference devices in stabilised transistor supplies and as a coupling element in transistor d.c. amplifiers.

More recent developments in semiconductor diodes include many forms of extra fast switching devices, of particular value in connection with data processing equipment. One of these, the p-n-p-n switching diode (a four element structure with two terminals) is capable of switching speeds in the millimicrosecond region. Another recent

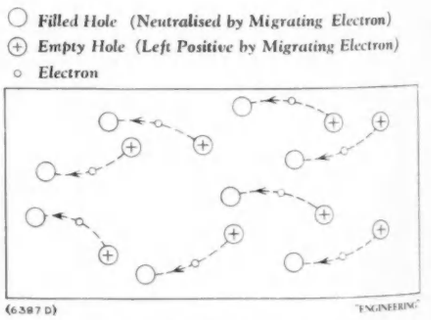


Fig. 4 Electrons migrate in one direction—effectively producing a " positive hole " migration in the opposite direction.

development, which has vast potential possibilities in connection with industrial electronic equipment, is a silicon controlled rectifier. This device has similar characteristics to the thyratron.

Parametric amplifiers are yet another significant recent development in the field of semiconductor diodes. These are used as variable capacitors in such a way as to form low noise u.h.f. amplifiers. Compared with other solid state devices such as the maser, parametric amplifiers have the advantage that they do not require a coolant for their operation. Most of the applications of these devices have been in classified Government work, but they will clearly be of considerable use in the future to the development of radar, telemetering, radio astronomy and satellite communication systems.

Other Semiconductor Devices

Although the photosensitive properties of semiconductors have been known for many years, the intensive research, which has followed upon the invention of the transistor, has led to numerous developments in this field. Photoconductors are now available which are sensitive to radiations extending from the deep ultra violet to the far infrared region. Numerically, the wavelength range of these devices extends from about 0·3 up to about 10 microns. In the visual photoconductive group, cadmium sulphide cells are now being made which are 20,000 times more sensitive than the conventional emissive type of photocell. Even from a very weak source of light, these new cells will produce enough current to operate a large relay directly.

Among the infra red sensitive cells, types are now available which are able to detect the heat radiation from a soldering iron from a distance of 100 yards. Such devices are extensively used as detectors in guided missile homing systems. Industrially, such cells offer a wide scope in low temperature radiation pyrometers for measuring temperatures from about 150° C upwards. Other cells, particularly of the indium antimonide and lead selenide types, open up new possibilities for spectrometers for analysing paints, plastics, resins, petroleum products and many other organic compounds.

Silicon photodiodes, or photovoltaic cells as they are often called, are now being used to convert solar radiation into electrical energy. Their main application so far has been to generate power for the electronic instruments in artificial satellites.

The thermoelectric junction effect, on which bimetallic thermocouples are based, is also being exploited in semiconductor engineering. Employing this principle, thermoelectric generators are now being produced in bismuth telluride and other related compounds. Studies in this field are being actively undertaken in several countries: for instance in Russia, radio sets have been manufactured to operate from thermoelectric generators driven from the heat of ordinary paraffin lamps.

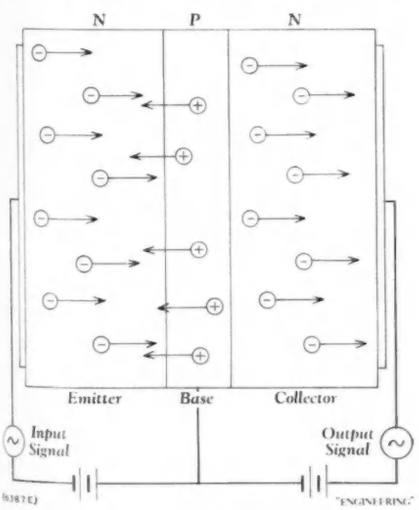


Fig. 5 Connection of n-p-n junction transistor. Fluctuations of the input signal produce identical fluctuations in the output circuit with an amplification of power.

Thimble containing twelve Mullard transistors emphasises the smallness of these devices.

In much the same way as it is possible to convert thermal energy into electrical power, so it is possible to remove heat by electrical energy. This effect is being used in a number of prototype semiconductor refrigerators. Elements of this kind have been produced by means of which a temperature of about − 60° C can be achieved. The practical applications of semiconductor refrigerators would appear to be quite considerable. They can be made compact, require little power, have no moving parts and expend with the necessity of a cooling liquid. Refrigerators of this kind have already been put to use in the Russian TU-104 airliner.

Manufacture

In manufacturing transistors and other semiconductor devices one of the most difficult tasks is to produce the basic material, say, germanium with a very low order of impurity. Although each manufacturing organisation has its own technique, they are all basically similar. Newmarket Transistors Limited, who are connected with the Pye Group, produce and handle " transistor germanium " on the following lines. After refining natural germanium until it has an impurity content of about one in a hundred million parts or better, small amounts of this germanium are placed in carbon containers together with a controlled quantity of " dope." This so called dope is the desired impurity such as indium or arsenic. The mixture is then heated until it melts, at about 900° C. A small " seed " of germanium is then lowered on to the surface of the molten mixture and, as the cup containing the mixture revolves, the seed is slowly withdrawn and a crystal of the required germanium begins to " grow " on it, shaping into a rod about an inch thick.

During the growing process a resistivity test is carried out to ensure that the correct degree of desired impurity has been obtained. Without this impurity the transistor would not work. When the crystal is correctly doped it is ready for sawing. In this process the germanium is trimmed and mounted on glass in a bed of wax, then sliced with a high speed diamond cutter. The slices are smoothed and etched down to a thickness of about six thousandths of an inch. These slices are then cut with an ultrasonic drill to obtain some 50 or 60 tiny wafers of germanium from each slice.

The subsequent handling of these tiny components and others that are even smaller, has lead transistor manufacturers to adopt mass production techniques that are similar to, and in some ways more exacting than, those used in the watchmaking industry. Many of the production techniques that have been evolved are peculiar to semiconductor engineering and have contributed significantly to the overall development of this new industry.

Future Trends

Semiconductor engineering and science has been advancing on a broad front for the past few years, and will no doubt continue to do so for some time to come. Developments are continuing in basic theory, materials, circuit techniques and manufacturing methods at an increasing rate. Although many problems are still outstanding, such as temperature and frequency limitation and the cost of production, they are being overcome very rapidly as intensive research continues throughout the world. It can be expected, with some degree of confidence, that the high frequency limit of the diffused germanium transistor will eventually be increased to several thousand Mc/s. It is also believed that there is no fundamental reason why power transistors with collector dissipations approaching one kilowatt should not be achieved.

In addition to the much used germanium and silicon, other materials, known as compound semiconductors, will undoubtedly be used in the future for many of the more special applications. For instance, silicon carbide and indium phosphide, both of which have a high energy gap, may be used for applications involving temperatures up to 500° C. Other compounds, such as indium antimonide and indium arsenide are being developed for devices which require a high electron mobility, such as photoconductors and Hall-effect devices.

Many potentially useful devices have recently appeared on the horizon, such as the field effect transistor, the space charge limited device, the unipolar analogue transistor, the spacistor and new multi-region devices, each of which will be the subject of intensive development and some of which will doubtless come to fruition. With these and many other developments yet to come it is reasonable to suppose that, within the next decade, semiconducting devices will not only have outstripped thermionic devices in most of their applications but that they will open up entirely new fields in both science and engineering.

USING SPIN

To explain the fine structure of atomic spectra it was suggested in 1925 that atomic particles should have angular momentum, or spin. Since then it has been conclusively shown that spin can have, in units of $h/2\pi$, values of 0, $\frac{1}{2}$, 1, $\frac{3}{2}$, etc., but no intermediate value. The highest observed value is 6, for the nucleus of vanadium 50. " Electrical Uses of Atomic Spin " was the title of an informal lecture given by Mr. G. Phillips at a meeting of the Institution of Electrical Engineers. He pointed out that the chief application of nuclear spin was found in devices relying on the action of protons, generally those in water. When a sample of water is placed between the poles of a magnet, the torque on the spinning protons causes them to precess, inducing a small alternating e.m.f. in a surrounding coil. Measurement of the frequency of the e.m.f. enables the external field to be determined, and the device can be used as a magnetometer. The great advantage of such an instrument is that no calibration of equipment is required. Applications have included airborne magnetic surveys, exploration of the Atlantic sea bed, and discovery of buried objects. Magnetic properties of protons have also been used as a means of determining the amount of light water in a flowing sample of heavy water.

RADIO ASTRONOMY AND NAVIGATION

Supernova could Jam BBC

CONSIDERABLE publicity has been given recently to the giant Jodrell Bank radio telescope and its use in tracking artificial satellites and probe rockets. There has always been a very close link between astronomy and navigation, and it is not surprising that the new techniques of radio astronomy are now being applied as navigational aids. Equipment far simpler than the Jodrell Bank telescope can be used for most of these applications, and many were reviewed in a lecture given recently to the British Interplanetary Society by Mr. C. M. Cade, of Kelvin and Hughes Limited.

Apart from terrestrial thunderstorms, the sources of radio noise may be considered under four headings. *Extragalactic Sources:* there are thousands of known "radio stars" outside our own galaxy (the Milky Way). Some of these are galaxies more or less similar to our own, several others are known to consist of two galaxies in collision (including the second most powerful radio source in the sky, Cygnus A, which has a total power of 10^{30} MW). However, most of the sources in this group are as yet unidentified, since they consist of objects at such vast distances that even the largest telescopes cannot detect them. *Galactic Sources:* twenty of the known 3,000 radio sources are located in our own galaxy. The most important of these (including the most intense celestial radio source, Cassiopeia A, or 23NSA) are supernovae—the remains of exploding stars. *The Sun* emits radio waves, but is an insignificant source in comparison with the "radio stars." While the visible solar radiation fluctuates by only about 1 per cent from year to year, the radio emission includes both a steady thermal component and abnormal radiation from sunspots and flares, and its intensity may increase many thousands of times in a few seconds. No other star is known to emit radio waves. *The Moon and Planets:* the moon is a continuous source of very weak signals. Bursts of radio energy of extremely high intensity are emitted from a particular spot in the South Temperate Belt on Jupiter. Pulses and bursts of radio waves are also emitted from Venus.

Work by the Collins Radio Company of Iowa and by the United States Naval Research Laboratory has led to the development of radio sextants operating upon solar radio emission. Models operating at a wavelength of 8 mm have been tested on the USS Curtiss and USS Compass Island and functioned well. Shorter-wavelength versions, of smaller dimensions, are being tested on large aircraft. The potential commercial market for the marine equipment is estimated at more than 15,000. The radio sextant can be used when the sun is obscured by clouds; an obvious military application will be for position finding in nuclear-propelled submarines carrying rocket missiles—these submarines may travel submerged for many thousands of miles using inertial guidance, and some error is inevitable.

Kelvin Hughes have also developed a solar radio sextant; this has a 4 ft diameter bowl and utilises 8·6 mm radiation. The power received is ample to operate an automatic tracking device. A supplementary instrument which has been constructed is an automatic lock-follow infra-red sextant working in the 6 to 8 micron band. The solar sextant can be used in cloudy weather but trouble is experienced in thunderstorms,when the instrument will lock on the discharges; in severe storms it appears to have a brainstorm and hunts from one flash to another.

Lunar sextants are likely to be developed for nocturnal use: in this case, 1·5 mm would be a practicable wavelength. Stellar radio sextants are also possible, but there are several difficulties to be overcome; the flux intensity at very short wavelengths is exceedingly low, and the more powerful longer-wavelength radiations necessitate the use of inconveniently large antennae. Artificial satellites in stable orbits at a height of a few thousand miles and carrying millimetric transmitters powered by solar batteries would offer much greater possibilities.

Celestial radio sources might be suitable as references in the mid-course guidance of ballistic missiles. Celestial navigation has already been employed for the Atlas rocket, but this involved the use of a photoelectric device in conjunction with a built-in memory of star patterns. A celestial radio guidance system might incorporate a tape recording of the sequence of radio noise patterns which would be picked up if the missle was on course. The recording would be continuously compared with the actual signals received and any difference used to generate error signals. Another market for solar and/or lunar sextants is in connection with rocket test vehicle trials.

Mr. Cade also referred to the possible effects on terrestrial communications of a close supernova. The estimated frequency of occurrence of supernovae is about one per 360 years per galaxy, and there have been four recorded cases in our galaxy since the Star of Bethlehem—in AD 369, 1054, 1572 and 1604. On this basis it is quite possible for a new supernova to appear at any time. Were this to be a fairly powerful one at the distance of the nearest star (4 light years) the radiation emitted would be such that the BBC European Service (150 kW transmitter) would become lost in the background noise at a range of 20 miles.

MEETINGS AND PAPERS

Association of Supervising Electrical Engineers

LONDON
Annual General Meeting of the Central London Branch. White Hall Hotel, Bloomsbury Square, WC1. Mon., 8 June, 6.30 p.m.

Institute of Information Scientists

LONDON
Annual General Meeting, at 6 p.m. "The International Development of Scientific and Technical Information Services," by Dr. Alexander King, at 7.15 p.m. Shaftesbury Hotel, Monmouth Street, WC2. Wed., 10 June.

Institution of Civil Engineers

LONDON
Annual General Meeting. Tues., 9 June, 5.30 p.m.*

Royal Institution

LONDON
"Colour in Inorganic Chemistry," by Professor R. S. Nyholm. Wed., 10 June, 9 p.m.

Royal Society

LONDON
"A Study of the Levels in ^{19}F Following the Beta Decay of ^{19}O," by C. M. P. Johnson and others; and "Nuclear Alignment of Manganese-56," by P. Dagley and others. Thurs., 11 June, 4.30 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927.)
Institute of Information Scientists. Apply to Mr. J. Farradane, Torran, Crofton Road, Orpington, Kent.
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577.)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669.)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335.)

COIL SPRING RESEARCH *New Laboratories*

New laboratories for the Coil Spring Federation Research Organisation, Sheffield, which will be ready in July this year, will be among the most comprehensive of their kind in the world. They will enable research to be carried out on springs made from the finest wires to bars of up to 2 in diameter. In addition to work on springs, research will be possible on materials in wire and strip form.

A major feature of the new buildings will be a comprehensive electroplating laboratory,which has been presented to the CSFRO by Messrs. W. Canning and Company Limited, Birmingham. This laboratory will enable extensive work to be done in the field of hydrogen embrittlement. Canning and Company have accepted the organisation's invitation to become Honorary Associate Members.

The effects of non-metallic coatings on fatigue life have been studied recently by CSFRO. So far tensile, hardness, abrasion and corrosion tests have been devised for thin films, and carried out on thirteen different resin and plastics protective materials. The research programme for this year also includes work to determine the influence of type of material, heat treatment and surface finish on the fatigue life of heavy duty springs.

Five new members joined the organisation last year, bringing the total to 97. It is hoped that the membership "century" will be passed this year. The CSFRO is rapidly approaching the time when it will take the final step to maturity—the attainment of research association status. This step would complete its natural growth so that it could take its place alongside the other cooperative associations in the Government scheme. Speaking at their annual conference, the president of the organisation, Mr. Salter Bache, said: "With our new laboratories, with the equipment and staff which we now have, we should consider moving to a higher status, in holding our place with other research establishments of the country."

PRODUCTIVITY COUNT

The Department of Scientific and Industrial Research has published a booklet called *Productivity Measurement in Great Britain.* It is a survey of recent work by Mr. T. E. Easterfield and provides a useful summary of a work of reference on the complications of measuring productivity in industry. The report is a survey of productivity measurement at the level of the individual plant together with such other related work as appears relevant. Studies based on statistics of whole industries are included only where they throw light on the problems of more detailed studies. The report deals briefly with the purpose of productivity measurement and the rest of the report is then split into four main sections. They are concerned with: the problem of multiple inputs, the problem of multiple outputs, the study of factors affecting productivity and the translation of results for practical application.

For those not acquainted with the jargon of this aspect of statistical work, the question of "multiple inputs" has become particularly important because most people using rough and ready methods of calculating productivity have used only one input factor, mainly labour. The question of "multiple output" is relevant because most crude calculations of productivity use only a value or a straightforward volume figure in the numerator of the productivity ratio.

On the Shelf

By Frank H. Smith

I have an interesting addition to the "what a crust" department. A printed postcard which says "We have borrowed from you the following item and it is now due for return. Would you please grant us an extension of the loan period. We will presume, if we do not hear from you, that a renewal has been granted." Such a card, to my mind, starts with at least two assumptions. First that the librarian who sends them out is going to make so many outside requests that he is not so much a librarian as a clearing house and, second, that his borrowers are mostly going to retain material for an inordinately long period. Most libraries consider it a point of honour to anticipate their clients' needs by having the material to hand, and those that lend usually point out that a loan system is not maintained to take the place of purchase or to provide material for intensive study.

I think I have mentioned before the symposium held last year at Oxford (17-18 September) on metals and alloys above 1,200° C. With No. 2 of the *Journal of the Less-Common Metals* (Elsevier) the publication of the papers is completed.

Publication AM-3 of the ASME lists the publications of the Society. There are quite a number of additions since last year and, as usual, new items are marked with an asterisk. 29 West 39th Street, New York 18, is the address.

A striking cover with just "Catalyst 1 Spring 1959" is intriguing, and it is not surprising on turning to the title page to see the sub-title "Industrial Journal of Shell Chemical Company." As usual with Shell publications, production is superlative; if Shell is mentioned it looks as though it is an afterthought and altogether the magazine is more like one of those chi-chi efforts that catch the eye just as one is about to catch a train. But this, being Shell, you know is good. Try Shell Chemical Company Limited, 170 Piccadilly, London, W1.

The Johnson Reprint Corporation (111 Fifth Avenue, New York 3) describe their works—rather quaintly I think—as new reprints. It sounds rather like new secondhand goods to me, but I suppose it's not. Most of the reprints are of journals.

An unusual business reply card comes from Heffer of Cambridge to advertise *The Annual Register of World Events*—founded by Burke (Edmund—not and Hare) and in its 200th year. The aforesaid card is in two parts, one of which is sent to Longmans Green advising them that you have sent the other part to Heffers to order your copy. If all this sounds too involved, see your own bookseller because this is all wrapped up with a special offer whereby you get a free copy of 200 if you order 200-3 now.

The National Bureau of Standards is producing a series of handbooks "designed to present in compact form comprehensive guides for State and local weights and measures officials." The fifth, which is NBS Handbook 67, is called *Checking Prepackaged Commodities*. It appears to be a guide to the drill for taking samples from a batch and testing whether they measure up to the declared net weight. At the end, an appendix gives a convenient table to check weight against price per pound. Being USGPO it should be obtainable from HMSO.

Anybody who thinks of taking up nuclear science should take a look at the *Annual Index to Nuclear Science Abstracts* (United States Atomic Energy Commission) and have another think. This covers 1958 and runs from 2,237 to 3,001 pages of the volume. The print is so small you almost need bifocals (actually, I do) and the entries range from the unbelievable to the almost indecent. All the same, if I were concerned with atomicism this is a volume I would not be without—which I'm glad I'm not.

IMPULSE AND REACTION

Steam Turbine Theory and Practice. By WILLIAM J. KEARTON. Seventh Edition. *Sir Isaac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, WC2.* (57*s* 6*d*)

Steam Turbine Performance and Economics. By ROBERT L. BARTLETT and J. E. MULDER and R. C. SHELDON. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, NY, USA;* and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, EC4.* (97*s*)

It is often said, and with truth, that the extent to which electrical energy is used in the service of the people is a measure of the standard of living of the community. The rate of expansion in the generation and distribution of electrical energy in industrialised countries since the war has been very rapid. An essential factor in this expansion has been the continuing development of the steam turbine which has held and consolidated its position as the predominant prime mover in central power stations so successfully that 97 per cent of the electrical power supply in this country is provided by steam turbo-generators. In the United States, where water-power is more abundant, the proportion was 76 per cent in 1955 and continues to grow. The subject of steam turbine theory, practice and performance is therefore one of great importance and it is dealt with from different aspects in the two books under review.

Professor Kearton's book *Steam Turbine Theory and Practice* first appeared in 1922 and has now reached its seventh edition. The scope of the book is comprehensive and the allocation of space well balanced. The principles of impulse and reaction are first described and throughout the book the term "impulse reaction" is used to denote 50 per cent reaction. The treatment of the flow of steam through nozzles and blades follows familiar lines and there are separate chapters surveying published experiments on nozzles and blades, the latter appearing now for the first time. Another appropriate addition is the chapter on vortex flow in steam turbines. This makes no direct reference to the writings of Darrieus but does refer to a recent paper by Wiebe, whose analysis leads to the conclusion that for best efficiency the degree of reaction should be appreciable at the root of the moving blade and then increase still more towards the tip. The design of rotors is considered from first principles in chapters dealing with stresses and critical speeds. The descriptive section dealing with examples of land and marine turbines has been brought up to date but nevertheless is perhaps the least satisfactory part of the book. It is almost inevitable that this should be so because the interest of such information is usually transitory, and for current information one must look to the technical press and papers published by the engineering societies. The style of presentation throughout the book is clear and free from unnecessary complication without being superficial.

The ultimate concern of Bartlett's book *Steam Turbine Performance and Economics* is with economics and in the writing of chapters 10, 11 and 12, which deal specifically with costs, he had the assistance of J. E. Mulder, while chapter 8, on gas turbines and the combined steam-turbine-gas-turbine cycle, was written by R. C. Sheldon. All three authors are associated with the General Electric Company of America. The book describes methods of calculation that have been developed for estimating relative power plant performance and the economic worth of alternative designs. Such calculations involve the determination of numerous small differences and a high order of accuracy is required.

The first three chapters deal concisely with the thermodynamics of turbine performance and heat balance calculations with worked examples. Chapter 4 presents basic efficiency data for a range of specific turbine designs together with correction curves or formulae for determining the effect of the many possible variables, such as volumetric flow, exhaust pressure, governing stage, moisture, partial load, and so on. The data related to steam turbines of disc and diaphragm design by one manufacturer but it is suggested that the method is broadly applicable to turbines of other design philosophies. The next three chapters constitute a study of the effects of variations in steam cycles and plant arrangement, the feedwater heating cycle receiving a degree of attention commensurate with its importance. One interesting point that emerges from a study of the turbine data is that the substitution of an 1,800 r.p.m. low-pressure turbine in place of a 3,600 r.p.m. turbine offers an appreciable improvement in efficiency for the same annulus velocity.

The cost data given in the later chapters of the book are interesting but for British readers must be regarded as food for thought rather than material to be used in calculations. This book is not easy to read but it contains a great amount of material, not readily available elsewhere, which is of importance to all who are concerned with the performance of steam turbine plant: it will repay careful study.

F. DOLLIN

DISTURBING AND DISTURBED

Interference between Power Systems and Telecommunication Lines. By H. R. J. KLEWE. Report Ref. M/T 126 of the *Electrical Research Association. Edward Arnold Limited, 41 Maddox Street, London, W1.* (70*s*)

The interference due to induction which may be experienced by telecommunication lines from nearby power lines can result in danger to persons using or working on the telecommunication system, in danger to the plant, or in disturbance to the information being transmitted. Remedial measures may consist of modifications to either the power or the telecommunication system, or of increasing the separation between them by moving one or other of the lines concerned. In the early days bitter disputes arose between power and telephone interests as to who should bear the cost of remedial operations, and it was realised that the only rational procedure was for the two sides to sit down together to establish agreed codes of practice.

Such committees were set up in several countries, and when the growth of long-distance telephony led to the formation of the International Consultative Committee for Long Distance Telephony (CCIF), one of its early tasks was to coordinate the work of the various groups studying interference between power and telephone systems, and to issue in 1926 directives which had the authority of experts drawn from many countries. Dr. Klewe, as a representative of the German Post Office, was associated with this work from its inception; when he came to England after the Second World War to join the Electrical Research Association, he was able to continue his studies and to assist the CCIF. The directives have been revised from time to time, the latest issue being in 1952, and a fresh revision is now being prepared.

The ERA has contributed notably to the subject, and its former director, the late Dr. S. Whitehead, together with W. G. Radley (now Sir Gordon Radley, director-general of the British Post Office) were the authors of classical papers which helped to transform the difficult mathematical theory into practical

forms suitable for everyday use. The CCIF directives have provided authoritative guidance to engineers in many parts of the world, who will be grateful to Dr. Klewe for providing a comprehensive text in this book which sets out so clearly the bases on which the directives rest.

Successive chapters in the first half of the book deal with the theory of coupling between circuits by the electric and magnetic fields; with the characteristics of power systems and phenomena which affect telecommunication systems adversely; with the effects in telecommunication circuits arising from interference; and with noise at audible frequencies. In the second half we find the chapters to which the engineer in a hurry will turn. These cover the effects to be considered for the various types of power and telecommunication lines, limits and approximate formulae; methods of reducing interference; and a most valuable chapter on hints for practical calculations and examples.

As an ERA report, the book has had the benefit of the approval by a committee on which the Post office, the Central Electricity Generating Board, British Railways and other bodies were represented, so that it is remarkably free from errors and omissions. The text is clearly printed (showing only very occasional traces of its printing in Holland), and is illustrated with many excellent diagrams and some useful charts.

In addition to the special chapter on practical calculations, the book is studded throughout with worked examples of the many formulae, which serve to give guidance to conditions likely to be encountered in practice; it contains a most comprehensive bibliography of nearly 600 items from many countries, and has an adequate index. The book may be thoroughly recommended to all who have to deal with interference problems, both on the disturbing and disturbed sides, and particularly to those engineers who, in Dr. Klewe's words, are concerned with developing new apparatus and new systems, and often forget the risk of interference.

A. ROSEN

The Reviewers

Mr. F. Dollin, B.Sc. (Eng.), M.I.Mech.E., M.A.S.M.E., is chief turbine designer with C. A. Parsons and Company, Limited.

Dr. A. Rosen is telecommunications consultant in British Insulated Callender's Cables Limited. He is a D.Sc. (Eng.), a Ph.D. and an Associate of the City and Guilds Institute.

NEW BOOKS

Mechanical Engineers' Handbook. Edited by THEODORE BAUMEISTER and LIONEL S. MARKS. Sixth Edition. *McGraw-Hill Book Company, Incorporated, 330 West 42nd Street, New York 36, NY, USA;* and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, EC4.* (151*s*)

A huge volume that can easily replace several other books containing the same information. The sixth edition, it has been compiled by over 100 contributors. Contains 45 " major topics," 40 reference tables and charts, and 86 pages of small-type index.

Engineering Manual. Edited by JOHN H. PERRY and ROBERT H. PERRY. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, NY, USA;* and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, EC4.* (74*s*)

The subtitle is " a practical reference of data and methods in architectural, chemical, civil, electrical, mechanical and nuclear engineering." An ambitious coverage for a manual but there is always the chance that that piece of information not given elsewhere will be found in this type of book. The publishers say it provides the swift answers to everyday problems in any major engineering field.

Handbook of Mathematical Tables and Formulas. Compiled by RICHARD STEVENS BURINGTON. *Handbook Publishers Incorporated, Sandusky, Ohio;* and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, EC4.* (25*s*)

For students. Divided in two parts: formulae and theorems from elementary mathematics (but going into calculus, integrals and vector analysis); and part 2—tables.

Rules for the Construction Testing and Scantlings of Metal-arc Welded Steel Boilers and Other Pressure Vessels. *Associated offices Technical Committee, 67 King Street, Manchester, 2.* (5*s*)

A 38 page pocket book with a self-explanatory title. The committee responsible is derived from five insurance companies.

Analysis of Pipe Structures for Flexibility. By JOHN GASCOYNE. *Sir Isaac Pitman and Sons Limited, Pitman House, Parker Street, Kingsway, London, WC2.* (45*s*)

Produced in the light of modern requirements for high-pressure and high-temperature piping systems where rule-of-thumb can no longer apply. The author is with an American company.

Plages et Cotes de Sable. By J. LARRAS. *Editions Eyrolles, 61 Boulevard Saint-Germain, Paris 5e, France.* (1,400 *F*)

Not fur but sand. Physical properties of the seashore, action and effect of waves and wind. " la presente étude intéresse tous les spécialistes d'hydraulique maritime, les océanographes, ainsi que les entrepreneurs de travaux maritimes et portuaires.

Bulletin de L'Association Technique Maritime et Aéronautique No. *58. Association Technique Maritime et Aéronautique, 47 Rue de Monceau, Paris 8e.* (4,000 *F*)

This, the second volume for 1958, deals particularly with the summer session in early July, 1958, in association with the Institution of Naval Architects.

Physical Laws and Effects. By C. FRANK HIX, JR., and ROBERT P. ALLEY. *John Wiley and Sons Incorporated, 440 Fourth Avenue, New York 16, NY, USA;* and *Chapman and Hall Limited, 37 Essex Street, London, WC2.* (64*s*)

An alphabetical collection of laws and effects which have been adapted and used either consciously or unconsciously in modern science. Three different cross reference systems simplify the book's use. References are given for each item to provide further reading.

Turbine Design for Aircraft Engines. By NORMAN C. BREDDY. *Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey.* (2*s* members, 3*s* 6*d* non-members.)

Draughtsman's view in brief: only 43 pages. For those who require a limited and presumably superficial introduction to the subject.

Versuche zur Anwendung vorgespannter Schraben im Stahlbau. Part II. By O. STEINHARDT and K. MÖHLER. *Stahlbau-Verlags GMBH, Ebertplatz 1, Köln, Germany.* (13·50 *DM*)

No. 22 of the Berichte des deutschen Ausschusses fur Stahlbau (news of the German committee on steel construction), the 64 pages conclude with a 40-item bibliography. The first part of this work appeared as No. 18 (1954) in the same series, with the same title.

I, x-Diagramme feuchter Luft. By MAX GRUBENMANN. Fourth Edition. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf, Germany.* (15·60 *DM*)

This, the fourth edition, has an additional part with the title " Austausch von Gut und Wärme zwischen Gas und Gut " which appeared originally in Zeitschrift Chemie-Ingenieur-Tecknik 1951.

Fitting the Job to the Worker. Project No. 335. Published by *The European Productivity Agency of The Organisation for European Economic Co-operation, 2 Rue André-Pascal, Paris, 16e.* (14*s*)

Reversal of the usual process is explained by the subtitle " a survey of American and European research into working conditions in industry." The booklet reports on a mission to the United States, where working conditions were investigated, and gives the papers read at an international seminar at Leyden.

Friction Charts for Air Flow in Straight Ducts and Pipes. By R. H. YOUNG and J. M. GASIOREK. *Sturtevant Engineering Company Limited, Southern House, Cannon Street, London, EC4.* (7*s* 6*d*)

Originally produced for internal consumption, the charts have now been made available to the general public.

Basic Electricity. By PAUL B. ZBAR and SID SCHILDKRAUT. Second edition. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, NY, USA, and McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, EC4.* (17*s* 6*d*)

Part of the American programme to meet the demand for technicians, this manual aims at providing " a firm basis for specialised training in any field of electronics." The second edition recognises the advances made with transistors in the past two years.

Theoretical Aerodynamics. By L. M. MILNE-THOMSON. Third Edition. *MacMillan and Company Limited, St. Martin's Street, London, WC2.* (40*s*)

Apart from corrections this book is little different from the second edition. It remains one of the " classics " on the subject.

Reibung und Schmierung fester Körper. By F. P. BOWDEN and D. TABOR. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf, Germany.* (41·40 *DM*)

This is a translation of the Clarendon Press's *Friction and Lubrication of Solids*, 1954.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Electronics

Microswitches. BURGESS PRODUCTS CO. LTD., Dukes Way, Team Valley, Gateshead 11. " Micro switchcraft "—a miscellany of data and development. No. 4 in the series.

Process Timers. ELCONTROL LTD., Wilbury Way, Hitchin, Herts. Standard range of electronic process timbers, cyclic timers and delay switches. Data Sheet TR/2.

Materials

Reinforced Plastics. WATSON INDUSTRIAL PLASTICS LTD., Regent Works, Woodsetton, Dudley. Glass fibre reinforced plastics, trays, tanks, ducts, etc. Leaflet.

Moulding Compound. BRITISH RESIN PRODUCTS LTD., Devonshire House, Piccadilly, London, W1. Polyester dough moulding compound, Rockite K501, with glass fibre reinforcing; its properties, uses and methods of handling. Technical bulletin T2.

Plastics Review. BAKELITE LTD., 12-18 Grosvenor Gardens, London, SW1. The 1959 edition shows in colour plastics in industry, in the home, and in the garden.

Insulation. THE MICANITE AND INSULATORS CO. LTD., Empire Works, Blackhorse Lane, Walthamstow, London, E17. Samica paper mica insulation in rolls of tape or sheet; thickness from 0·0016 to 0·004 in. Leaflet.

Glasscloth Laminates. MIDLAND SILICONES LTD., 1 Knightsbridge Green, London, SW1. Silicone bonded glasscloth laminates—a general guide to their uses and properties. Silicone Notes L18-2.

Titanium. IMPERIAL CHEMICAL INDUSTRIES LTD., Millbank, London, SW1. Two leaflets " Titanium for Chemical Plant " and " Titanium for Aircraft " describe the use of this metal in these two industries.

Aluminium. REYNOLDS METALS CO. PRD-3, Box 2346, Richmond 18, Virginia, USA. The practice of machining aluminium is described in a 32 page booklet; tool angles, speeds, etc, are given.

Busbars. NORTHERN ALUMINIUM CO. LTD., Banbury, Oxfordshire. Rectangular aluminium busbars in two grades, electrical purity and conductor alloy. Properties and range of sections available.

Nimonic. HENRY WIGGIN AND CO. LTD., Wiggin Street, Birmingham 16. The Nimonic alloys for high temperature applications. Leaflet.

Bored Bars. KEETON, SONS AND CO. LTD., Keetona Works Greenland Road, Sheffield 9. Hollow bored bars up to 22 ft long, 12½ in diameter hole. Tolerances up to ± 0·001 in on the bore. Booklet gives range.

SURFACE ACTIVATING AGENTS

Detergents are surface activating agents and are recognised by their ability to stabilise foams and emulsions. However, these chemicals are only part of a much wider range of activating agents which affect the interfaces between air and liquid, or liquid and liquid. The type of surface activating agent opposite to a detergent is the one which will break a foam or an emulsion, will cause a foam to collapse or an emulsion to separate out into two phases. Both stabiliser and breaker agents have their uses.

MAKING FOAM

Clears Waterlogged Gas Wells

From the American Bureau of Mines comes the news that detergents have proved to be successful in clearing natural gas wells. "Tired" or "drowned" gas wells are ones in which water or oil accumulations in the well bore hinder or prevent gas evolution. Forced into such wells with a small portable pump, the detergent solutions capture gas in the liquid "blockage" which then rises to the surface as a column of foam. Once the blockage is removed, the gas can rise through the well casing and production is restored. The agents required for making foams in oil are of course different from those required in water.

This technique has been employed successfully in selected wells in Texas, Kansas and Oklahoma where it has been operated as a batch treatment. Research is under way, however, to make the process continuous.

DESTROYING FOAM

Lessens River Contamination

A standing Technical Committee on Synthetic Detergents has made progress. Trials of a synthetic detergent which would give rise to less river pollution and cause little or no foam on rivers, it reports, have been encouraging. These trials reflect an approach alternative to the method of breaking foams by adding further chemicals. In fact, the action of some household detergents cannot always be suppressed by chemical foam breakers; at least, on this subject, opinions are still divided. The new compounds in question could be derived from sugar, and experimental work at Durham University has shown that materials so based are readily broken by bacteria. More development work is still required; until these new detergents become available, if they ever do so, the existing detergent chemicals will continue to cause chaos on rivers and in sewage works. In an effort to combat this an experimental plant is being considered around a process whereby detergents are removed into the surface of a foam produced by intense aeration, which can be subsequently removed in an activated sludge plant. The Committee end on a happy note by reporting, that at least in present concentrations, fish will not find detergents intoxicating.

BREAKING EMULSIONS

Lessens Sea Pollution

Unlike the preceding demands on agents for making foams in gas wells, and for breaking foams in sewage works and rivers, the third example of surface activating agents is one where the need existed for breaking emulsions. This centred around ships, where an agent was sought which would cause oil/water sludges and emulsions to separate. If this could be found, it could allow complete separation of reuseable "dry" oil from water, which becomes mixed during ballasting of so-called empty tanks carrying oil fuel on passenger ships, or carrying cargo in oil tankers.

DSIR cooperated with Glovers (Chemicals) Limited, Leeds, Yorkshire, to produce Fomescol, a tailor-made chemical designed for this task. In trials with the Admiralty, the agent has proved not to be specific in action towards any one oil or with regard to concentration, and allows complete separation of water from heated oils.

A further series of trials has been carried out on tank cleaning in dockyards, and once again the separation has proved satisfactory, with 80 per cent recovery of the surface activating agent. The result of these trials means that if ship-lines find this chemical economical to use, there will be little excuse for dumping oily water.

SOLVENTS DE PARIS

With fascinating names like Zimax, Malester, Bergol and Adhex comes a host of resinates, solvents and plasticisers developed and manufactured by S. A. Sheby of Paris. Media of the oil, cellulose or synthetic type will find themselves compatible, for instance, with Mouillant 54; this wetting agent is unusual because it is completely non-specific. For white enamels based on zinc oxide, Mouillant 54 eliminates curtaining and ropiness.

The organisation responsible is Charles H. Windschuegl Limited, 1 Leadenhall Street, London, EC3. Contact with this firm will yield data sheets on these latest additions to their range; there is calcium resinate with a melting point of 150° C and an acid value of 70 used particularly in helio inks—of this there are also special and neutral varieties; there is bornyl acetate—a technical grade neutral solvent having a greenish yellow colour and an odour described as "smooth, and similar to lavender oil"—needless to say it is used in polishes and perfumery; then there are varnish resins, plasticisers for leather lacquers and a naphthenate paint drier. For adhesive compositions comes the last of these Paris models—Adhex. It is said to impart body and adhesion but is not dissolved by alcohol.

HEALTHY FLOOR COATINGS

A new type of floor coating introduced by Corrosion Limited of Southampton under the name of Glocrete SR is claimed to contribute to overcoming the difficult problem of continuous dusting and the harbouring of bacteria in concrete floors. This coating is based on a synthetic rubber and incorporates a powerful germicide. A brushed coat applied with "rubber squeegee or broom" will be about 0·003 in thick, and normally two such coatings are required. On smooth concrete one gallon will go a long way—300 sq. ft, in fact. This coating is touch dry after 30 minutes. After about 10 hours it reaches a hardness "60 per cent that of plate glass," but although semi-glossy, it has a non-slippery surface.

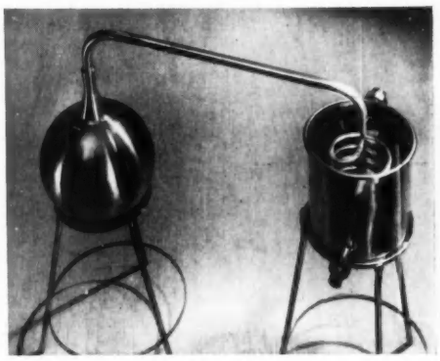
Made in a range of colours from "garage red to aluminium" (which may well have to be changed to garage aluminium to red in the future) Glocrete SR is intended primarily for factories and public buildings.

PLATINUM STILL

Constructed entirely in pure platinum, the chemical distillation plant shown in the illustration has been designed and manufactured by Johnson, Matthey and Company Limited, Hatton Garden, London, EC1.

The still is one of three destined for a Far Eastern government. It consists of a spherical distillation unit of 5 in diameter fabricated from platinum 0·020 in thick, which is linked through a tube (11¾ in long by 0·040 in bore and 0·015 in wall thickness) to a helical cooling coil; this has 5 turns and is constructed from platinum tube of 0·200 in bore and 0·012 in wall thickness.

The purpose for which the still is required has not been disclosed.



LOW MELTING POINT POTTING GLASSES

For Electronic Components

A new group of low melting glass compositions has recently been developed at Bell Telephone Laboratories, 463 West Street, New York 14, NY, USA. Composed of varying amounts of sulphur or selenium and the heavy metals arsenic and thallium, the glasses become very fluid at temperatures between 125 and 350° C, a temperature range 300 to 400° C lower than any previously known low melting glass. In this temperature range they have viscosities approximately equal to that of castor oil at room temperature, a viscosity suitable for coating devices by a simple dipping procedure.

The glasses range electrically from semiconductors, to insulators with a minimum resistivity of 10^6 ohm-cm. Maximum resistivity of both sulphur and selenium ternary compositions is over 10^{14} ohm-cm.

Chemically, the glasses show the same durability characteristics as glasses in general. They are insoluble in water, dilute alkalis, acids and organic solvents, but are attacked by concentrated alkalis. Several compositions are stable to air oxidation to above 250° C.

The compositions exhibit extremely low permeability to both water and helium, and possess good wetting characteristics with respect to most metals—properties which are not normally available in organic coating materials. Thermal expansion coefficients range from 20 to 50 $\times 10^{-6}$ per °C. Thermal conductivities are of the order of 0·0007 cals per sec per sq. cm per °C per cm. These low melting glasses are also unusual in that they can be evaporated and condensed as thin glass films. The selenium containing compositions bond particularly well to ceremics and the silicate glasses.

The development of these unusual materials has opened new possibilities of encapsulating semiconducting devices, capacitors, resistors and printed circuit boards. It appears that in most cases proper choice of composition, design and processing can circumvent potential difficulties at very low temperatures due to mismatch in thermal expansions.

Coating of semiconducting devices with these low melting glasses is under study. In experiments with silicon diodes, for example, excellent initial characteristics are said to have been attained. In addition, improvements have been observed when such units are heated or operated.

According to Bell workers, thallium was the only element of the 22 investigated as additives to the arsenic sulphur system which produced a large lowering of the melt viscosities.

GAS LIQUOR TRANSPORTED IN STAINLESS STEEL

Successful examination of a 3,250 gallon transporter of ammoniacal gas liquor fabricated three years ago in 18/8 titanium stabilised stainless steel, has lead E. H. Jones Limited to add six more such tankers to their fleet. Initial cost was little more than twice that of a corresponding one in mild steel, but the life of three years, with the promise of many more years in service is upwards of three times.

Firth Vickers supplied the stainless steel which was fabricated by W. P. Butterfield into the 23 ft long frameless articulated tanker shown in the illustration. It was a cooperative effort which lead to a recent examination undertaken by the three companies. Tar-like deposits were generally scattered over the surface, but they had not been the sites of accelerated corrosion; in fact at no point was there any sign of corrosion which would reduce the life of the tanker. The liquor with which the stainless steel had contended was typically concentrated gas liquor containing ammonia, carbon dioxide, hydrogen sulphide and traces of cyanide compounds with a pH greater than 8, but an occasional load of tar and tar acids had been transported—7,500,000 gallons in all in the three year period.

It is interesting to note that metal arc welding was employed throughout on the 8 s.w.g. sheet, and that external mild steel mounting members and fittings were welded to stainless steel doubler plates to avoid dilution effects on the internal surfaces.

This tanker had plied between various gasworks in the South Eastern Gas Board to the Central Chemical Works at Phoenix Wharf, East Greenwich, for E. H. Jones Limited of East Greenwich, London, SE10.

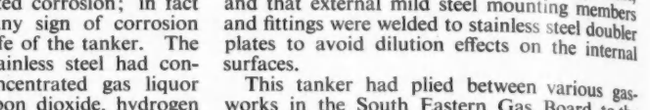
Liquid Phenol in Nickel

Another transportation difficulty presented itself to ICI—this time with phenol. Phenol for the manufacture of plastics must be pure and colourless, but it is contaminated by iron and iron alloys. In its pure state this chemical is a colourless liquid solidifying at 41° C. The design of the tanker therefore demanded not only a corrosion-resistant material, but allowance for insulation and heating to keep the liquid fluid in cold weather.

W. P. Butterfield were awarded the contract for fabricating the 3,090 gallon tanker—in AT nickel, this material being a grade made for chemical plant by Henry Wiggin.

The shell was made from 10 s.w.g. sheet, with 131 nickel electrodes used for metal-arc welding of nickel to nickel. Nickel to mild steel welds occurred at doubler straps and were made with 141 electrodes. Great care was taken to avoid sulphur contamination of weld metal. Operators wore cotton gloves and all weld surfaces were degreased with carbon tetrachloride and wire brushed with stainless steel wire brushes.

Heating was to be effected with a steam coil—once more in nickel. Fibreglass cladding was added as insulation and an 18 s.w.g. aluminium skin fitted outside this. The finishing touches came in the form of internal cleaning with Deoxidene 125.



Construction of road tankers in special materials is repaid by longer life or less contamination.

POLYPROPYLENE AND POLYETHYLENE FIBRES AND ROPES

Production of fibres in polypropylene and polyethylene has commenced at the Coventry works of British Celanese Limited. Polypropylene first made its appearance in the United States just over a year ago but now two firms in the United Kingdom have announced their intention of making it and it will be featured at the International Plastics Exhibition this June. Meanwhile Courtaulds have developed methods of spinning a high tenacity yarn. Chemically the material is in the same family as polyethylene, but has even lower density and a higher melting point of 325 to 340° F.

The high tenacity polyethylene yarn is known as Courlene X3 and is spun from a high density polymer provided by British Resin Products. This yarn is intended for ropes and cordage; it has a low specific gravity of 0·96 and ropes made therefrom will float on fresh or salt water. Tenacity and abrasion resistance are said to be comparable with yarns of nylon and Terylene.

Ropes made in polyethylene fibre exhibit all the properties of the polymer itself—low water absorption, chemical inertness and resistance to fungal attack and rotting; flexibility is maintained, moreover, down to − 70° C.

The manufacturers of the ropes in polyethylene yarn are the Gourock Ropework Company Limited of Port Glasgow, Scotland, and Lancashire Hill Rope and Twine Company Limited of Stockport, Cheshire.

Trials with a 2½ in rope as mooring line and 1½ in rope in runner tackle for a 30 ton yacht are said to have been entirely satisfactory over a period of one year; the only noticeable effect of service was a loss of shine. The crew of the yacht paid tribute to the easy handling qualities of the rope, saying, for example, that unlike ordinary rope, it showed no tendency to slip through their fingers when wet.

NEW POLYETHYLENE DIP COATING

A Ziegler type high density polyethylene powder is now being offered for dip-coating. It is called Telcothene HD powder and is made by the Telegraph Construction and Maintenance Company Limited, Theobald's Road, London, WC1.

Properties of Telcothene are those of Ziegler type polyethylene, the softening point being about 20° C higher than that of the low density material. Although it will withstand boiling water for short periods, the maximum long term working temperature is 80° C. Its melting point is 125 to 130° C and its room temperature hardness is 63 to 74 on the Shore D scale. The protection against chemicals is even greater than that afforded by the low density material.

Coherent coatings may be obtained at temperatures as low as 160° C, the upper limit being over 200° C for prolonged heating or over 300° C for very short periods. The better strength and hardness recommend this coating for hard use—the manufacturers give hand rails and control wheels as examples. It has already been used for coating ships' propellers and for internal and external coating of pipes.

DESULPHURISATION AND RECARBURISATION OF CAST IRON WITH POWDER INJECTOR

Sulphur in cast iron may be reduced in a matter of minutes to virtually any value, certainly less than 0·02 per cent, by injecting calcium carbide into the melt. This process, long recognised by metallurgists as being technically feasible, has been made possible by development of a powder dispenser and lance system by the British Oxygen Company Limited, Cleveland Row, London, SW1; it has been called the BOC Metallurgical Powder Dispenser and has been designed for use in foundries and melting shops. As with chlorine degassing of light alloys by lance injection to remove hydrogen, success comes primarily from bringing the reactants into intimate contact. The sulphur bearing slag is dry and floats to the surface of the melt.

Recarburisation, it is claimed, is also efficiently performed by injecting graphite powder; as with calcium carbide, the powder is carried in a stream of nitrogen through a graphite or refractory lance. The injection times are sufficiently short, apparently, not to allow nitrogen pickup and embrittlement, and even an improvement in properties has been observed as the result of grain refining. A final carbon content of up to 4 per cent is readily obtained.

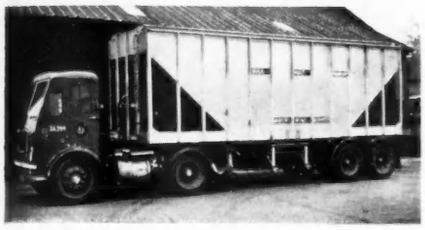
If wear on lances can be kept to an economic level, this method appears very promising for treating cast irons, and even for recarburising cast iron and steel scrap. The powder dispenser will discharge powders up to 30 lb a minute, from a hopper with a capacity of 2 cu. ft.

LIGHT ALLOYS FOR CHASSIS AND BODY

Aluminium alloys are widely used in the construction of commercial vehicle bodies, but a new type of grain carrier built for British Road Services illustrates that they can also be used satisfactorily for chassis construction.

The new grain carriers, two of which have been built by G. Scammell and Nephew Limited, London, in conjunction with Carrimore Six Wheelers Limited, also of London, have a chassis frame of channel and angle sections in Noral (B51SWP). Two main channel members extend the full length of the body and are braced by three full-width cross-members of the same section at the front and by four similar members at the rear, leaving a clear opening of 12 ft in the centre of the frame. Longitudinal members at the rear accept the semi-trailer bogie. All the above members are assembled with cadmium-plated high-tensile steel fitted bolts and gusseted with aluminium alloy plates.

The body, which is 24 ft 6 in long by 7 ft 1½ in wide, is constructed from Noral sections, sheet and plate. The outer upright framing material is of a special top-hat section, and the corner posts heavy angles. The side panels are secured to the upright members by Avdel lock bolts and both panels and uprights are bolted to the



main chassis members. The underside of the body is supported by channel sections and is in the shape of a hopper. The roof, which is cambered for drainage purposes, has a frame of top-hat sections and is covered in sheet. All the alloys referred to above were supplied by Northern Aluminium Company Limited.

The grain carriers, which have a capacity of 1,000 cu. ft, have been left in the unpainted condition to take advantage of aluminium's resistance to corrosion. They are expected to prove economical to operate because of the lightness of the completed vehicles and the low maintenance costs associated with aluminium bodies.

BETTER FLUID POWER CIRCUITS

Although oil hydraulic equipment is being widely used, there is frequently a severe limitation to the usefulness and efficiency obtained because of bad circuit design. This is the state of affairs as described by the National Engineering Laboratory at East Kilbride.

Three reasons are suggested to explain the observation. First is that the factors involved in design are not sufficiently appreciated at design level; too often it is believed that no special knowledge is required to "pipe-up" between the dependent units. Furthermore, too much circuit design is dominated by mystic numbers—as beloved by the "practical man." Typical examples are the limiting fluid speeds accepted, ranging from 5 to 15 ft per sec irrespective of application. Third, and finally, by far the biggest obstacle to better design is the lack of reliable information on the flow characteristics of the different fittings now available.

A simple example of how both space and money can be saved in a circuit is that of a flow-control valve. There is a common tendency to call for a valve which has the same bore as the pipe itself. In many cases to make such a valve effective as a flow controller, it has to be nearly closed to introduce sufficient head loss to control the flow. There are several disadvantages in this arrangement, not the least being wire-drawing across the valve faces.

In a sound design, a valve size would be chosen so that in the open condition it is just on the edge of its effective flow-control field, so that the full scope of the valve can be used in controlling the flow. Such a valve would be much smaller than the "straight-through" valve and would therefore be more economical in both space and cost. To design on this basis, however, the loss that can be tolerated when the valve is fully open and the head loss characteristics of the valve must be known. Generally speaking, this data cannot be obtained.

There is now at the Laboratory a test rig in which head loss characteristics of fittings can be determined. Firms are invited to send representatives with a range of their products to work on the rig under the supervision of the Laboratory staff. Firms interested in taking advantage of this service should write to the Director, NEL, East Kilbride, stating the type of product and the range of tests they would require.

DE-ICING PROTECTION FOR THE FAIREY GANNET

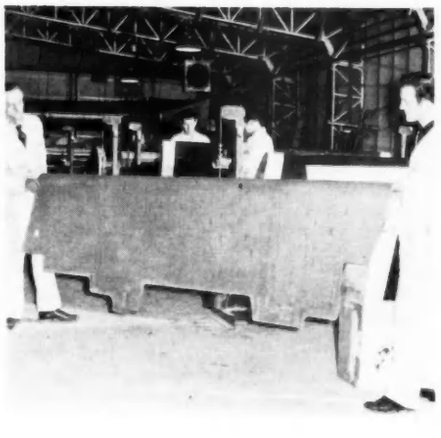
The largest and most complex application of the Napier "Spraymat" de-icing system yet undertaken, and the first to include the mainplane of an aeroplane, is that on the Fairey Gannet, early warning aircraft now on order for the Royal Navy. Spraymat is also used to protect the air intake of the Double Mamba turboprop engine.

In all, this version of the Gannet has nearly 200 sq. ft of Spraymat heated surface, two-thirds of it on the mainplane. The application to the mainplane created a manufacturing problem.

Normally, Spraymat is applied in the Napier workshops direct to the surface to be protected, but as the leading-edges of the mainplanes of the Gannet are not detachable a new technique had to be evolved by which large prefabricated heaters of resin-bonded glass cloth with flame-sprayed elements could be applied to the wing leading-edge as finished components, instead of being built up layer by layer.

Because it has to fold for stowage below decks the wing is in three sections, and the illustration shows one of the three Spraymat heaters used on each wing. Heaters for each section are built up on special moulds and attached to the leading-edges by a strong adhesive compound, and a series of inflatable tubes are used to press the heater firmly against the leading-edge sections to exclude all air from the joint face while the adhesive is setting.

The process is completed by fitting mushroom-headed terminals, the undersides of the heads of which make contact with sprayed copper leads on the surface of the heater. Cables are crimped into the stem, and nylon nuts, running on the stems which extend through holes cut in the wing leading-edge surface, secure the terminals

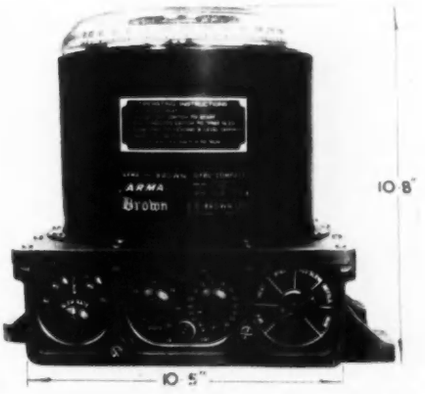


in position. An insulating compound is afterwards applied over the exposed heads of the terminals. The tail-unit heaters, in general, follow normal Spraymat practice.

The mainplane heaters are divided into leading-edge and chordwise breaker strips (continuously-heated in icing conditions) and 32 cyclically heated areas. Current for the cyclic circuits passes through four switches controlled from a sequence timer. The tail unit heaters are divided into eight circuits which are operated in conjunction with the electrical heaters on the propellers. Two cyclic switches are used, one for the tail unit and one for the propellers.

GYROSCOPIC COMPASS WEIGHING 30 LB

Following their recent association with the American Bosch Arma Corporation, S. G. Brown Limited of Watford are now producing a north-seeking gyroscopic compass of advanced form which differs markedly from the conventional models. The Arma Brown gyro can be used either as a north-seeking compass or as a directional gyro. Initially it is being offered in two forms: as a marine compass, shown illustrated, and as part of a complete automatic land vehicle navigation system.



The complete unit—excluding the motor generator set—is self-contained and measures only 10½ in by 10½ in by 10¾ in high; the weight is about 30 lb. No special gyro room is required and the compass can be sited anywhere in the ship; installation requires no more than a bracket in the chart room or wheelhouse. Electrical connection is by two screw-in plugs.

The gyro is encased in a hermetically sealed spherical housing which is completely immersed in a sealed tank containing a high density fluid. Frictionless suspension is achieved by suspending the gyro in the fluid at neutral buoyancy and keeping it centred in the tank by two pairs of ligaments. Ideally the centre of gravity should be coincident with the centre of buoyancy and the makers say that they succeed in doing this to within a few millionths of an inch. Twisting of the ligaments creates precession in both azimuth and tilt and makes the gyro north seeking; electrical pick-offs and transistorised amplifiers provide the control. Synchronous outputs are provided as a basis for repeater and automatic steering operation.

The compass has been developed to the point where the drift rate is less than 0·1° per hour when used as a directional instrument. When used as a north-seeking gyro compass the maximum error will not exceed ½° under all conditions likely to be experienced at sea. If started cold from 10° off true north, the compass is capable of settling in approximately 30 minutes. Without shock-mounts the instrument can accommodate accelerations of 15*g* and is suitable for inertial navigation and space travel equipment.

INSTRUMENTATION *at* NUCLEAR POWER STATIONS

By Denis Taylor, M.Sc., Ph.D., M.I.E.E., F.Inst.P.

Plessey Nucleonics Limited, Northampton

The instrumentation of nuclear power plants involves a number of special problems, apart from the central problem of the start-up, control at constant operating power, and the shut-down of the reactor. Some of these special problems are discussed in the present paper.* They include (i) the detection of burst fuel elements or slugs; (ii) the measurement of the neutron-flux distributions throughout the core of the reactor, and (iii) the problem of the "in-pile" neutron detector.

DETECTING BURST SLUGS

In the case of the majority of types of reactor used at the present time the uranium fuel elements are sealed in gas-tight containers. This is done to prevent the escape of fission products into the coolant circuit. It is also necessary to be able to localise a fault in a fuel-element container to the particular channel in which it occurs, so that the channel concerned can be discharged before the escape of fission products causes serious contamination of the coolant circuit, and it is worth installing, if necessary, a relatively large amount of equipment to achieve this.

Various systems can be used for the detection of burst fuel elements, but the method which has proved most popular and has been generally adopted for the gas-cooled power reactors is that used at Calder Hall, already described by Long, Laithwaite and Cunningham.[1] The system depends on the detection of gaseous fission products which decay into active solids. Certain of the gaseous fission products decay by beta-emission into positively charged particles, which may be attracted to a negatively charged electrode. In the actual system the gas is first filtered and then passed into a precipitation chamber where the solid daughter decay products of the fission products are deposited on a negatively charged wire electrode. A moving wire is used, and after a period of time in the precipitation chamber, it moves into the detection apparatus, where the active products deposited on the wire are detected by means of a scintillation counter. The complete apparatus comprising a wire machine, a precipitation chamber, a scintillation counter, and the associated counting-rate meter and recorder is shown schematically in Fig. 1.

In practice a sample tube is attached to each channel top and is brought out through the pressure vessel and the biological shield. Here they are paralleled in groups of four and are then passed to a bank of rotary selector valves and thence to precipitation chamber/detection apparatus of the type already described. Thereafter the gas from all the channels passes to the main coolant circuit by an auxiliary compressor.

A schematic of the sampling system is shown in Fig. 2. It will be noted that extra precipitators are provided for bulk monitoring, these being in addition to the monitoring of the selected channels in a sequence determined by the operation of the rotary selector valves. This is necessary, because in the Calder Hall installation 54-way selector valves are used with a sampling time for each group of 4 pipes of $\frac{1}{2}$ minute. A complete scan therefore takes about $\frac{1}{2}$ hour and as this may be a long time to wait, it is useful to have continuous monitoring facilities available with the bulk monitoring system, even without location facilities, so that the advent of a serious fault arising can be noted immediately.

In practice the selection system allows location

* Presented to Section G of the British Association at Glasgow on 28 August, 1958.

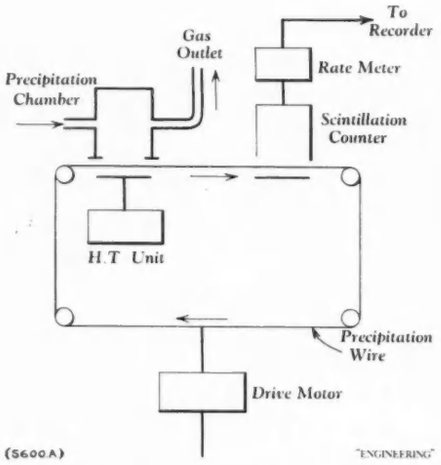


Fig. 1 Schematic arrangement of Calder Hall system for detecting burst fuel element.

of a fault to a group of 4 channels. It is then necessary to operate manual cocks in the paralleling system to determine which channel in the group of four is the faulty one.

This gaseous fission-product detection system has proved very satisfactory at Calder Hall and similar equipment has been or is being installed at Calder B, Chapelcross A and B and the French station at Marcoule. Substantially the same equipment is proposed for the first-stage CEGB power stations. Nevertheless, the Calder system is somewhat elaborate and efforts are being made to minimise the cost by:

(i) locating the selector valve as close as possible to the pressure shell to reduce the amount of stainless-steel tubing necessary;

(ii) the use of a combination of primary and secondary selector valves;

(iii) the use of a coordinate pipework system; and

(iv) connecting in parallel more than 4 pipes.

For the first-stage CEGB reactors, considerable savings are being effected by the use of some of these methods. These and other matters are discussed in a new paper by Cunningham, Kelly and Hough[2] presented at last year's Geneva Conference, and details are given of improvements in the selector valves and the precipitators which will be incorporated in burst fuel-element detection systems to be used on some of the later CEGB stations. One type of precipitator which has been shown to give an improved performance is shown in Fig. 3.

Apart from the application of this gaseous fission-product detection system to gas-cooled reactors, it has also been applied to water-cooled systems. It is then necessary to include a scrubbing device to extract the fission-product gases (krypton and xenon) from the liquid coolant. Quite a simple scrubber is effective as these gases have a low solubility in water, and it has been found convenient to use helium gas as the scrubbing gas.

It has also been found convenient to use a different type of precipitator. The wire is replaced by a conducting rod of large diameter as the precipitation surface, and this is reciprocated backwards and forwards between the precipitation chamber and the detection apparatus. In this way the same surface is used continuously and so there is a possibility of the sensitivity of the system being reduced as compared with the wire system because of the build-up of activity on the rod. On the other hand, the system is very simple and can be made mechanically more reliable than the wire machine. In fact, the reduction in sensitivity is quite acceptable and has been shown to give a satisfactory performance with the heavy-water reactor DIDO at Harwell, and it is proposed to use it on a number of installations abroad.

The rod spends 30 seconds in the precipitation chamber and is then withdrawn and spends a further 30 seconds in the detection system before again returning to the precipitation chamber, so that a complete cycle takes 1 minute. In some cases it is convenient to arrange a gas-proportional counter around the rod as the detection apparatus. This can provide 4π geometry, resulting in good overall detection efficiency and, moreover, allows operation at elevated temperature if necessary.

Various versions of this rod precipitator have been developed for different purposes. In some cases they are used in complete burst fuel-

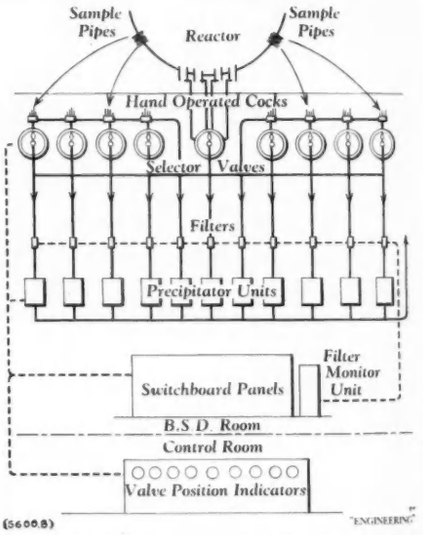


Fig. 2 Arrangement of sampling system.

element detection systems in the same way as the wire machines (Fig. 3), but they are also being employed as the sensitive elements in bulk monitoring schemes as well as in loop monitors for experimental work.

NEUTRON FLUX MEASUREMENTS

It is periodically necessary to measure the neutron-flux distribution across the core of the reactor. This is necessary to ensure that the fuel-element loading has been adjusted to give the flux distribution necessary for efficient operation and efficient use of fuel. In the case of the Calder Hall installation a neutron-activation technique is used. In this method a suitable material, usually in the form of a wire is introduced into the reactor core and is irradiated for a specific time. It is then withdrawn and the induced activity (which is proportional to the original neutron flux) is measured externally at

each point on the wire with an ionisation chamber. It is thus possible to determine the neutron-flux distribution for each channel in which the wire is placed. The method has given satisfactory results, but is time consuming, and a more direct method would be preferred.

A method which is showing considerable promise is that proposed by Gray,[3] using a small neutron-sensitive ionisation chamber which is lowered through the core of the reactor on the end of a high-temperature flexible cable from a winding head installed in a standpipe on the pile

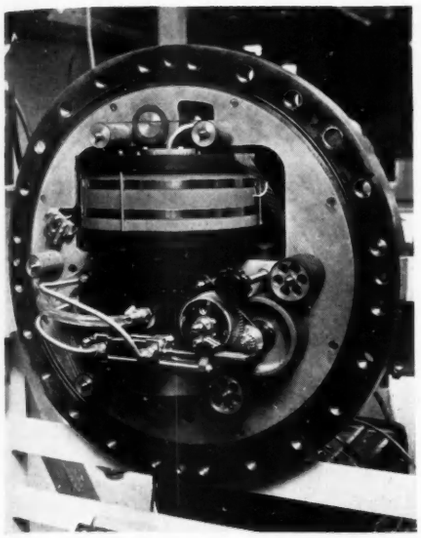


Fig. 3 Advanced design of precipitator.

cap. The output of the ionisation chamber is passed from the winding head to a chart recorder. A number of winding heads are installed across the pile cap and each head is operated in turn from a control panel adjacent to the recorder. When not in use the ionisation chamber is raised by winding the cable to the base of the standpipe. Fig. 4 shows a typical winding head.

The ionisation chamber has an overall size of 3½ in long by ⅞ in diameter. It is constructed of stainless steel, a ceramic-to-metal vacuum seal forming one anode support, the other consisting of a high-purity alumina ring. The outer case also forms the cathode, and the anode or collector electrode is maintained at approximately 500 volts above the earthed cathode. Both anode and cathode are coated with a layer of elemental boron-10.

The ionisation chamber is supported by a stainless-steel and quartz-fibre coaxial cable. This consists of a stainless-steel core covered in turn with braided quartz-fibre insulation, an intermediate braided shield, a further layer of quartz-fibre insulation, and a final stainless-steel outer braid. The outer braid is brazed to the case of the ionisation chamber, the core being connected to the collector electrode. The internal shield is not connected to the chamber, its function merely being to prevent the collection of gamma ionisation on the core. It is maintained at the same potential as the core, but is not connected to the measuring circuit. At a flux of 3×10^{13} n per sq. cm per sec the ionisation chamber current is 3 mA the accompanying gamma current being approximately 5×10^{-7} A. With this gamma background the range of measurement possible for negligible gamma current is thus two decades. At lower neutron fluxes, however, the gamma background itself is lower and the operational range of the system is better than three decades with an accuracy of measurement of $\pm$ 2 per cent; and better than four decades at a lower accuracy, depending on the irradiation history of the reactor core.

Ionisation chambers of this type can be made to operate at temperatures in excess of 500° C. The design of the winding head depends upon the type of reactor, but it is usual to provide for both automatic and manual operation, and to provide both mechanical and electrical devices for indicating the wire position as well as alarm and safety circuits which operate in the case of mal-operation of the system.

"IN-PILE" DETECTORS

The small neutron-sensitive ionisation chambers employed for flux-distribution measurements normally spend only a few minutes in the core of the reactor whilst the measurement is being made (once a week on the average). Boron-depletion troubles are not therefore serious. However, for reactor-control purposes (control of operating power level) the chamber must be in the core or near the core the whole time the reactor is operating. To avoid boron-depletion troubles, it is usual to locate the neutron-sensitive ionisation chamber in a thermal column outside the reactor core. For this method to be satisfactory, the neutron flux in the thermal column must be directly proportional to the neutron population in the reactor core, i.e. the fraction of neutrons escaping to the thermal column must be constant. This matter has been discussed in a recent paper by Taylor,[4] and it now seems, particularly as higher and higher power reactors are to be built, that some "in-pile" measurement for the control of operating power level must be provided.

There seems no ideal answer to this problem. It seems probable, however, that advantage can be taken of the work already done in developing the ionisation chamber for flux-distribution measurement, but to avoid the boron-depletion troubles by using a gamma-sensitive chamber.

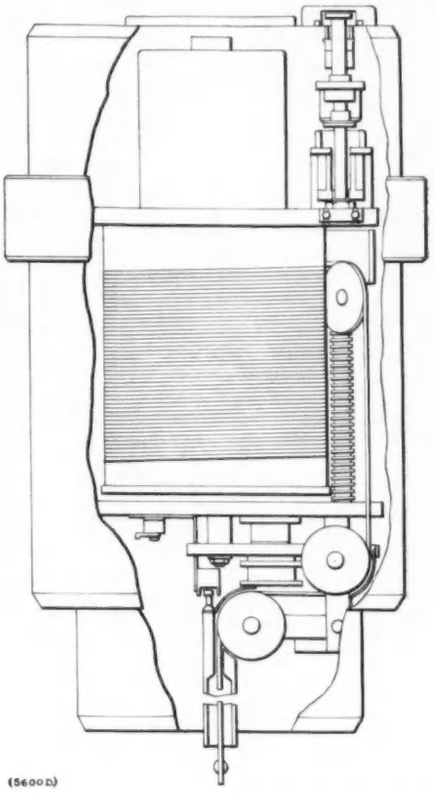


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Fig. 4 Winding head for flux-distribution measurement, showing main details of construction.

This would allow in-pile detectors to provide control facilities at powers near the normal operating levels, but neutron-sensitive chambers in the thermal column would have to be employed for the start-up of the reactor and control of the power at low levels.

REFERENCES

[1] Long, E., Laithwaite, J. M., and Cunningham, K. W., "The Detection of Faulty Fuel Elements." *Journal BNEC*, vol. 2, p. 197 (April 1957).

[2] Cunningham, K. W., Kelly, D. A., and Hough, G. V., "The Detection of Burst Fuel Elements in Nuclear Reactors." Communication to the Atoms for Peace Conference, Geneva, 1958.

[3] Gray, A. L., "Measuring Flux Distributions in Power Reactors." *Nuclear Power*, vol. 3, p. 171 (April 1958).

[4] Taylor, D., "The Measurement of Radioactivity." *Proceedings I.E.E.*, vol. 104B, p. 7 (January 1957).

THE DIGITAL TERRAIN MODEL *Locating Routes by Computer*

An integrated system that links photogrammetry to electronic computers in the resolution of civil engineering problems is contained in the digital terrain model devised by the Massachusetts Institute of Technology.*

Briefly, an area of land can be specified in terms of coordinates and heights; this data can then be fed to a computer and, given an appropriate programme, the machine will determine an optimum route between points A and B in terms of balanced cut and fill, specified slopes, limiting gradients and curves, and cost of doing particular jobs.

As in all approaches by computer, it is possible to examine the effect of a large number of variables and, if the condition can be defined, arrange that the machine shall select an optimum solution.

* *The Digital Terrain Model: Theory and Practice*, by C. L. Miller and R. A. Laflamme. Publication No. 117, Department of Civil Engineering, MIT.

As evolved at the moment, the terrain data for the DTM may be taken from a contour map or directly from a stereoplotter. No special instrumentation is necessary in either case, but the use of automatic recording apparatus facilitates taking the data. In addition, the system is being extended to include economic factors and traffic movement data, but development of the programmes to take account of this evidence is proving a major task. If landscape architects would define their requirements, the model should easily accommodate the necessary instructions.

The research which led to DTM and the associated computer programmes was sponsored by the Massachusetts Department of Public Works in cooperation with the Bureau of Public Roads. The results are being made available to all highway authorities interested in using the system. In return, users are being asked to contribute to the growth of the system by reporting on experiences, suggesting improvements, and furnishing details of programmes.

The application of DTM to highway engineering has already been mentioned, but the same considerations apply to railways, canals, airports, dredging, river works, and the location of dams and embankments. Direct estimations can be made of excavations for borrow pits, quarries and open-cut mines. Surface change studies can be made relating to settlement, erosion and silting. Analysis can be made of water supply schemes, drainage and transmission lines projects of all descriptions.

In essence, it may be said that whenever major land works are to be considered, the DTM offers a possible approach. Photogrammetry will usually offer the only practical approach to the problem of obtaining the required data and the electronic computer makes it possible to consider a degree of analysis that has hitherto been impracticable.

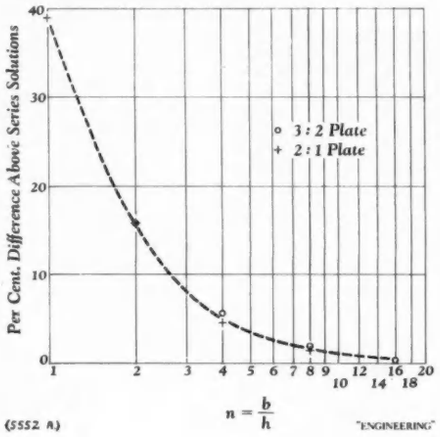
RELAXATION METHODS *for* TWO-DIMENSIONAL PLATE PROBLEMS

By J. A. N. LEE, B.Sc.(Eng.), Ph.D.

After an extensive use of the relaxation technique for defining deflection-values at the nodal points of flat plates having various support conditions and subjected to concentrated loads perpendicular to the surface, it has been found possible to examine these solutions in the light of experimental results and of other solutions obtained by more classical methods. In general, it has been found that, in the range where deflections are small in comparison with the slab thickness, relaxation solutions agree well with experimental results, provided that the grid size is small and that the residual is well dispersed; the summation of residuals being a small fraction of the smallest possible residual change at any node due to unit displacement by that node.

The several examples chosen displayed the characteristic influences of certain techniques and properties connected with relaxation solutions. For instance, a demonstration was given where design stresses were required at one particular point in a slab and where it was possible, by the prudent use of the principles of reciprocality of solutions and decreasing grid size, to obtain results with an equal amount of labour but with an increased accuracy over the normal method. Moreover, the examples chosen showed that the final accuracy was independent of the positioning or distribution of the load, but that it was dependent upon the ratio of the final residual to the total load value and the grid size. Further investigations showed that the percentages of error included in the preliminary solutions to differential equations, where the grid size had been successively reduced, followed similar curves in tending towards the experimental and classical solutions, where such results were available. A typical example is shown in Fig. 1, which represents the errors included in successive relaxation solutions to two cases of centrally-loaded simply-supported plates with different span ratios.

Fig. 1 Percentage difference of relaxation solutions above series solutions.



In solving equations by finite differences, it is often stated that the error is a function of the grid size squared. On this premise, it has been assumed that the convergence curves have the general equation

$$w = a + b\,h + c\,h^2$$

where w is the function required, h is the grid size, and a, b, and c are arbitrary constants.

Having obtained three solutions it was possible to evaluate the coefficients a, b, and c. Substituting $h = 0$, "ultimate" values of w were obtained. It was found, however, that until the convergence curve drawn through these three points had passed the point of maximum curvature, there was a tendency for this "extrapolation" method to overshoot the classical solution or experimental results. The position thus obtained is illustrated in Fig. 2. Other extrapolation formulae have been considered, the most successful being that expounded by M. A. Salvadori, which need only entail the use of two known solutions. At the same time, it was found that, by using these two solutions, the extrapolated effect was a far better estimate of the result obtained at the next grid size reduction than for the "ultimate" solution. Salvadori's formulae were considered at some length in his paper "Extrapolation Formulae in Linear Difference Operators," published in the *Proceedings* of the First United States National Congress on Applied Mechanics, held in 1951.

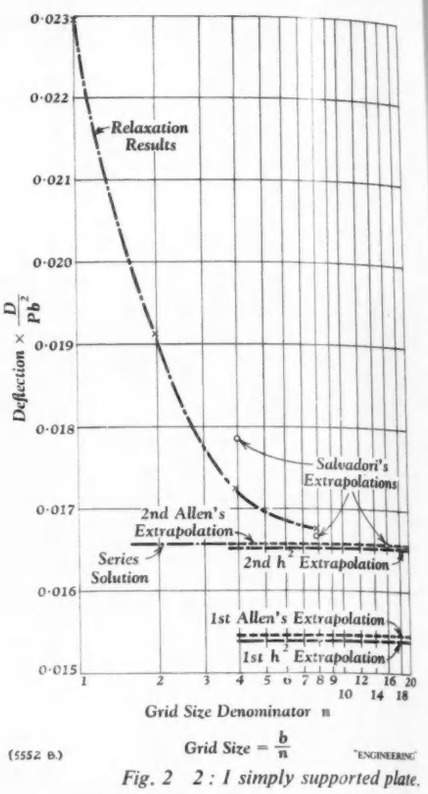


Fig. 2 2 : 1 simply supported plate.

The confidence with which the results of similar analyses, together with the improvements, can be accepted depends not only on the degree of accuracy sought, but also on the ability of the computer. It is hoped that these observations will assist in alleviating some of the suspicions held by some engineers regarding the use of relaxation "devices" and that they will open up the field of solution which the considered devices have appeared to probe.

Copies of the complete paper, of which the above article is a digest, are obtainable from the Administrative Secretary, Departments of Civil and Mechanical Engineering, The University, Nottingham, price 10s.

25,000 BHP IN ONE MARINE ENGINE IN SIGHT

The race to produce the largest marine diesel engine continues. Burmeister and Wain now claim that they could build a new engine type (the 84-VTBF-180) which, with 12 cylinders, would be able to develop 25,000 b.h.p. in daily service. It has been designed for the propulsion of very large ships, especially supertankers.

With an output of 25,000 b.h.p. a single-screw diesel plant is a practical proposition for tankers up to 65,000 tons cargo capacity. The new engine has a cylinder diameter of 840 mm and a stroke of 1,800 mm; in daily service it would develop 2,100 b.h.p. per cylinder to give 25,000 h.p. on the 12 cylinders.

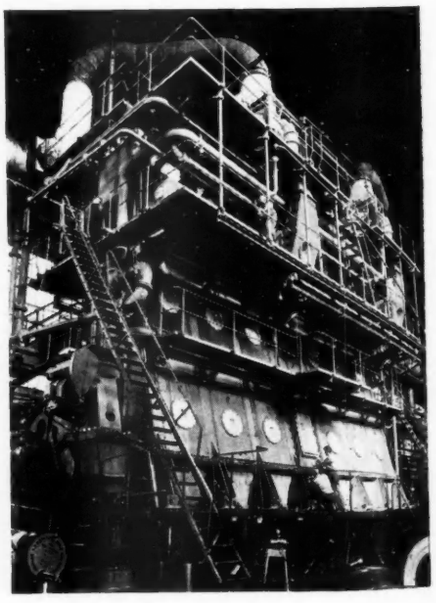
The first engine with the new large cylinders has just completed test-bed trials. It has only six cylinders and the contracted capacity is 10,400 b.h.p. or 1,730 b.h.p. per cylinder, corresponding to the lower degree of turbocharging that was catered for when the order was placed. The engine is for a 19,000 ton tanker being built at the Nakskov Shipyard for the East-Asiatic Company.

The workshop trials were begun in April and the makers express themselves satisfied with the results obtained. At full load, corresponding to a mean indicated pressure of 9·5 kg per sq. cm (140 lb per sq. in), the fuel consumption is approaching 0·34 lb per b.h.p.-hour and B and W describe the temperatures in the cylinder walls, covers and pistons as being "the same as in their earlier engines." The height of the engine type from the seatings is 36 ft 7 in; a 12 cylinder engine would be 72 ft 9 in long and weigh about 885 tons, equivalent to just under 80 lb per b.h.p.

LARGEST MOTOR TANKER

Compagnie Navale des Petroles in Paris has taken delivery of a new ship, the Altaïr, which at 47,835 tons deadweight is the world's largest motor tanker. The ship is equipped with a 12-cylinder turbocharged Burmeister and Wain diesel engine built under licence by Penhoët. The engine has a bore of 740 mm and a stroke of 1,600 mm and develops 15,000 b.h.p. at 115 r.p.m. Altaïr is the fourth ship equipped with this diesel engine type and a total of 37 such plants have now been contracted for.

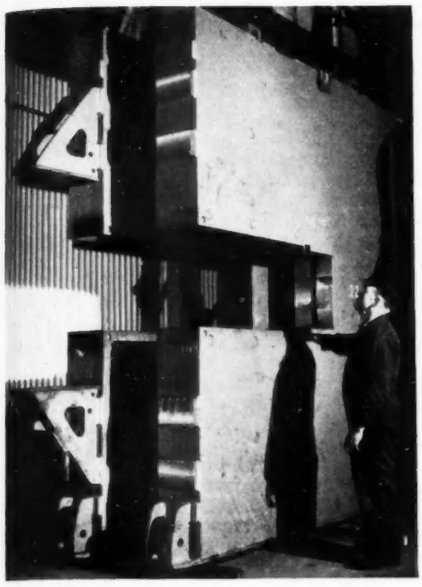
Altaïr is 224 metres long and has 23 tanks with a total capacity of 64,500 cu. m (approximately 48,000 tons of crude oil). Compagnie Navale des Petroles already owns a considerable number of ships powered by B and W engines, and among the orders placed by the company are four ships of more than 46,000 tons deadweight, each, with similar engines from Penhoët.



MAKING MAGNET SECTORS *for* NUCLEAR RESEARCH

Heavy Components to Precision Limits

Although much information has been published about the equipment used for nuclear research, very little has so far been forthcoming on the subject of producing the equipment itself. The very high standards of quality and dimensional accuracy needed in such equipment set engineers many problems, and as there was often no precedent for the work in question, methods and machinery had to be designed to suit it. To produce the 7,000 ton electro-magnet core for the 7 GeV proton synchrotron now being made for the Rutherford High Energy Laboratory at the National Institute for Research in Nuclear Science, Harwell, a complete production layout has been devised and installed at the Manor Works, Wolverhampton, of Joseph Sankey and Sons Limited (a member of the GKN Group of Companies). All the plant has been specially ordered, and some of it specially designed, for the work, and modern mechanical handling methods are used throughout. The magnet sectors are now in full production at a rate of six a week.



(Above) Two of the Sankey magnet sectors for the new Harwell synchrotron.

THE magnet—the biggest in the British Commonwealth and the heaviest in Europe outside the USSR—will be 160 ft diameter, and consist of 336 sectors, each weighing nearly 20 tons and made to close dimensional tolerances. Each sector is 10 ft 5 in high, 9 ft 3 in wide and 12½ in thick, and is built up of 45 plates of 1 per cent silicon steel; each plate is insulated from its neighbours. As it was not possible to obtain 10 ft wide material each plate is made from two 5 ft pieces butt welded together. The plates are ¼ in thick, except the outer pair, which are of ½ in material.

The specification calls for very high quality welding and weld dressing, with close attention to plate thickness; annealing with accurate temperature control, both for the sake of the electrical properties and for avoiding thermal distorion; shearing to ± 1/32 in on a 9 ft and 10 ft dimension; complete removal of all scale and surface defects; insulation of each plate from its neighbour, and very close dimensional tolerances on machining and assembly.

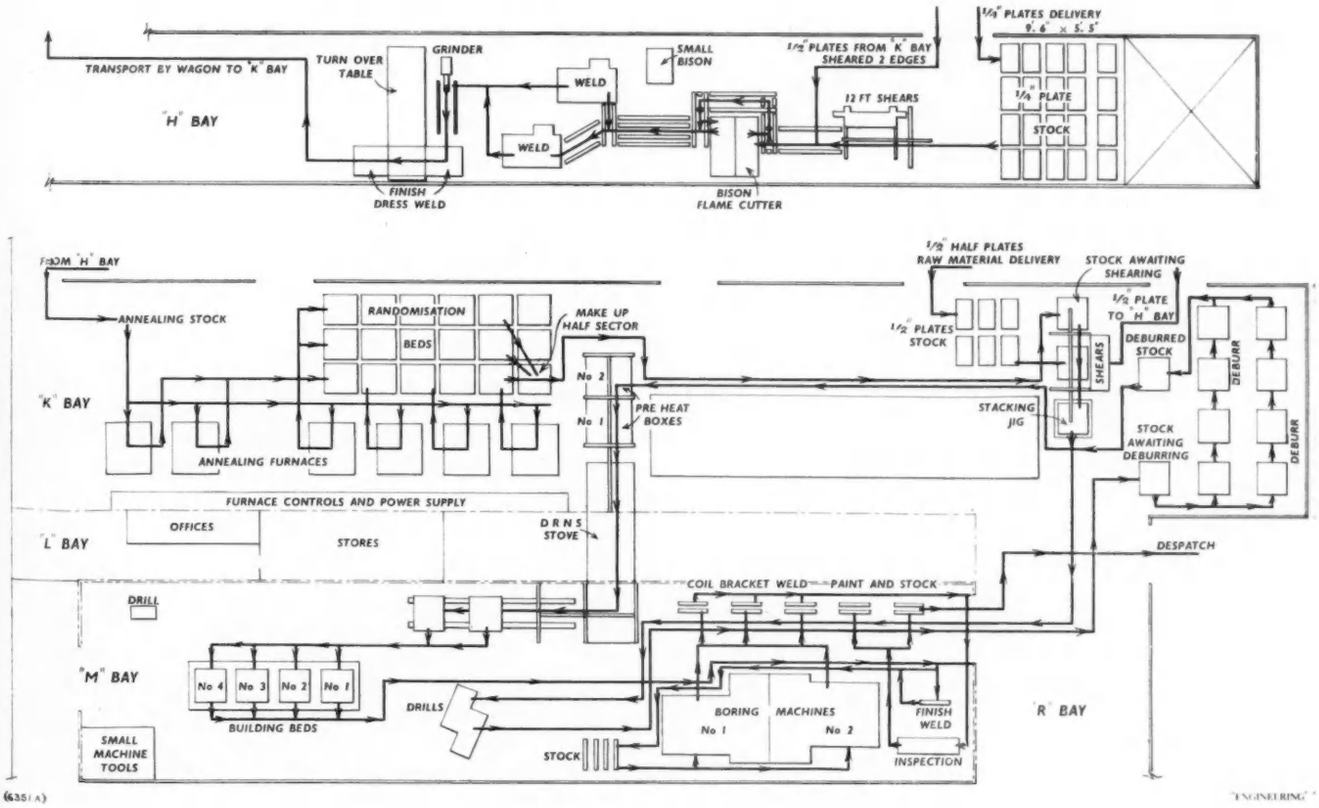
PLATE PREPARATION

Steel plates are received from the rolling mills marked for cast, ingot and position of ingot, placed in stock and withdrawn from stock in such a manner as to randomise any variations within each cast. Two plates are then selected to form a pair, inspected, and sheared on two sides at right angles.

A flame cutting machine, with a magnetic head and a dowelled template, then cuts the throat profile to within 1/16 in of final machined size. Cutting speed is 120 ft per hr in ¼ in plate and 84 ft per hr in ½ in plate.

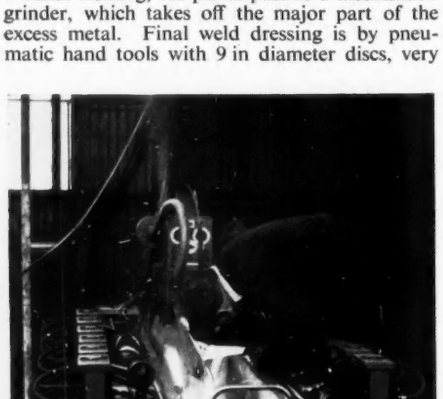
For welding the flame cut plates a special machine using a Quasi-Arc CO_2 welding head and a clamping fixture of joint Quasi-Arc Sankey design is installed. Clamping is pneumatic, with a total pressure of 60 tons, distributed to 12 pads each 12 in long, the machine bed being designed to withstand these forces without distortion. Four removable copper backing bars are fitted, with a camber for the correct amount of plate deflection to offset welding distortion. The weld is of the close square butt type, and Fusarc 8 s.w.g. continuous electrode is used as the filler material. Current is applied at 28 to 30 V and 540 A, and the plates are welded at about 17 in per min, with full joint penetration.

(Below) Flow diagram for magnet sector production.



For the ½ in plates a two-pass procedure is used, the plates being turned over for the second welding run in a special manipulator of Sankey design.

After welding, the plates pass to a mechanised grinder, which takes off the major part of the excess metal. Final weld dressing is by pneumatic hand tools with 9 in diameter discs, very close control being exercised to prevent undercutting.



Welding the two 5 ft plates together calls for very accurate clamping; this fixture was designed specially.

ANNEALING

One of the most difficult of the operations required to produce the magnet sectors proved to be the annealing of the plates. Annealing is necessary to flatten the plates, homogenise their structure and optimise their electrical properties, and the treatment consists of heating a stack of plates in a bell-type furnace to a temperature of around 800° C and cooling them again. Difficulties arose because the plates are roughly 10 ft square, and it would be all too easy to raise or lower the temperature of one part of a plate too quickly, causing unequal expansion or contraction, which would result in buckling. Much experimental and development work had to be carried out before a satisfactory annealing procedure was established. As finally developed, the furnace system has three sets of electric heating elements; in the furnace bell, in the hearth, and in a special throat heating block. These three heat sources are controlled independently to maintain the heating gradient within safe limits.

Another problem which had to be overcome was the effect of "crowning" of the plates. An unavoidable defect of the rolling process, crowning, which causes the plates to be slightly barrel-shaped in cross section, can be ignored for most purposes, but had to be taken into account in annealing the magnet plates. As the amount of crowning varies from cast to cast, tables have been worked out for compensating for this effect over a range from 0·002 in to 0·012 in thickness variation between centres and edges. Compensation is made by inserting at specified positions within the stack of plates pieces of cold-reduced strip 0·013 in thick and from 3 in to 18 in wide. These fit, in effect, into the gaps at the edges of the plates and support them when they become plastic at the higher temperatures.

Plates are stacked, on top of each other, on a flat base of 1 in mild steel, until a height of 4 ft 3 in is reached; compensation pieces are inserted as required as the stack is built up. The weight of the complete charge is about 80 tons. Twelve thermocouples are placed in the charge, and the throat heating block is lifted into position. An inner cover of 17 per cent Cr steel is then placed over the charge, a sand seal being formed at the bottom. Nitrogen gas is fed into this cover during the annealing operation. When the cover is in position, the bell furnace is lowered over it, and heating commences. With a total rating of 500 kW heating proceeds slowly, about 8 days being required to reach the final temperature of approximately 800° C. During the whole of this time the heating elements are under automatic control.

Cooling takes place under a specially designed cooling hood, which is lowered into position to replace the furnace. This hood is essentially an insulated cover with adjustable flaps at the base and at the outlets on top, which enable the rate of air flow through the hood, and therefore the rate of temperature fall, to be controlled closely. Total time for a complete annealing cycle is about 16 days and the electricity consumption is in the region of 20,000 units.

When annealed, each plate has to be flat to within $\frac{5}{16}$ in over the whole area. The annealed plates develop a permeability as follows:

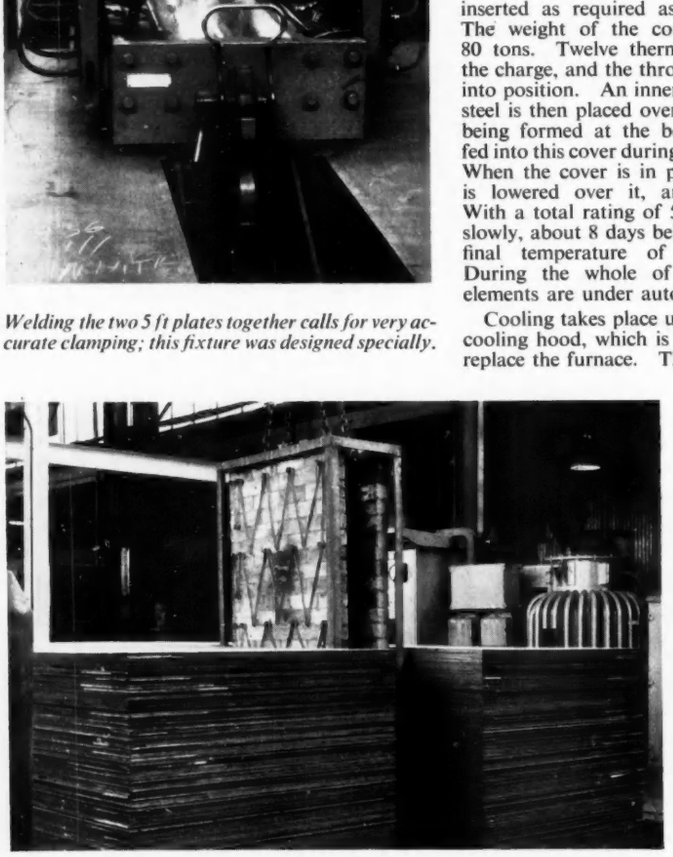
B in kilogauss	H in Oersteds
10	About 3½
13	,, 6
15	,, 10
18	,, 90

Coercive force developed is 1·5 to 2·0 Oersteds.

RANDOMISING

A sector must contain plates from at least five casts, and these must come from at least four different annealing charges, with all three annealing positions (top, middle, bottom), represented, and all positions within the ingot included. For this purpose the plates, after leaving the annealing furnace, go to randomisation beds, of which there are 15, in three rows of five. Any one cast is sent to a set of three beds and the annealing charge is divided into three parts, all the tops going to one row of five beds, all the middles to another row, and all the bottoms to another. For sector assembly, one plate is lifted off each bed in turn, the magnet crane going down the rows of five, and this process is repeated until the required number has been drawn off.

A shearing operation follows annealing, all sides having to be true and square with each other to a tolerance of $\pm \frac{1}{32}$ in; to achieve this a strict shearing sequence is followed. The plates are then laid in stacks in drilling jigs and



(*Top left*) *Uniform heating during annealing is essential. This throat heating element is part of the special equipment used in the bell furnaces.*

(*Top right*) *In order to even out any small annealing or mill variations, a large area is devoted to a randomisation procedure.*

(*Right*) *Sectors are built up on a special stand and held down by 50 tons of weights while the side plates are welded on.*

the necessary holes are drilled by two Asquith radial machines with 7 ft arms.

Surface finish is of particular importance, and following the drilling operation the plates are lifted singly by magnet crane to a table 30 in above ground level, where the whole surface is cleaned and polished by a manually controlled machine modified from a floor surfacer, and equipped with a silicon carbide abrasive belt. The plate is next transferred to a second table, where all holes and edges are deburred. It is then turned over and the other side is treated in the same way.

INSULATING

Each plate is inspected and then placed in a steam coil heated pit where it remains for 24 hours to reach a temperature of about 80° C. Lifted out by magnet crane the plates are placed singly on the extended piston rods of four air cylinders attached to the platform of an Avery self-indicating weighing machine. After weighing, the plate is lowered by the air cylinders to a conveyor and passes through an automatic spray booth, which gives it a coating of a special insulating material developed by Sankey's and known by the name DRNS; its use is exclusive to the Sankey organisation. The heat of the plate dries the DRNS, and a row of gas jets finally hardens the material as it emerges from the spray booth.

The weight of each plate, as determined just before it enters the spray booth, is recorded by the inspection department, and this figure is used in determining the final build-up of the pack forming a magnet sector. Each sector contains 42 or 43 laminations of $\frac{1}{4}$ in material, with or without one $\frac{1}{8}$ in lamination. The weight can be controlled to $\pm$ 252 lb on a total weight of 41,944 lb (18¾ tons) by varying the number of laminations at this point, that is, the weight variation is to $\pm \frac{1}{2}$ per cent.

SECTOR BUILDING

Three building beds are provided, and on a three day building cycle a continuous flow of work is maintained. Sectors are built in a horizontal position on a bed shaped to suit the final shape of the sector side. The first $\frac{1}{2}$ in plate is brought by magnet crane from the insulated plate stock, inspected and then lowered into position. Insulating paper is placed between the plates, and thin strips of crown compensating paper are laid along two edges and varnished. Resin placed round the throat area coats the additional insulating material. A $\frac{1}{2}$ in plate on the top completes the building of the sector.

As each plate is positioned an electrical resistance reading is taken with an Avometer between each pair of adjacent plates. Fourteen insulated tie bolts are inserted and tightened to 20 lb-ft with a torque wrench. Then a shaped grid is placed on top of the sector, and 50 tons of weights are distributed equally over it. Thickness checks of the sector are then taken. Thickness within the throat area must be within the limits 12·710 in and 12·860 in, and along the back and edges it must not exceed 12·500 in. An electric heater is placed within the throat to accelerate the curing of the resin, and side plates are welded into position, 80 per cent of the welding being done at this stage.

The weights and grid are removed, the tie bolts tightened to 100 lb-ft torque, and a rapid curing resin is applied to the nuts to lock them in position. This completes the work on the building bed, and the sector is removed to a weld-finish station, where the welds which were out of reach on the building bed are completed. A coat of grey paint is then sprayed on the sector which stands for seven days before machining.

MACHINING

All machining operations are done with the sector in a vertical position, the equipment used being two Asquith horizontal boring and milling machines. The machining sequence is: machine the active section of the throat to within 0·020 in of finished size and to a tolerance of $\pm$ 0·005 in; rough and finish machine the rear section of the throat to a final tolerance of $\pm$ 0·015 in; machine $\frac{1}{2}^\circ$ of taper on rear of sector for full height of 10 ft 5 in to a tolerance of 5 min on angle and plus 0·000 in minus 0·020 in on thickness. Two slots 2½ in by 1½ in are then machined in the throat to a tolerance of $\pm$ 0·030 in; the active throat faces are finish machined to $\pm$ 0·005 in and a total tolerance of 0·004 in on parallelism of the two faces; finally, four pads are machined on the front of the sector to provide an accurate datum for fixing coil brackets.

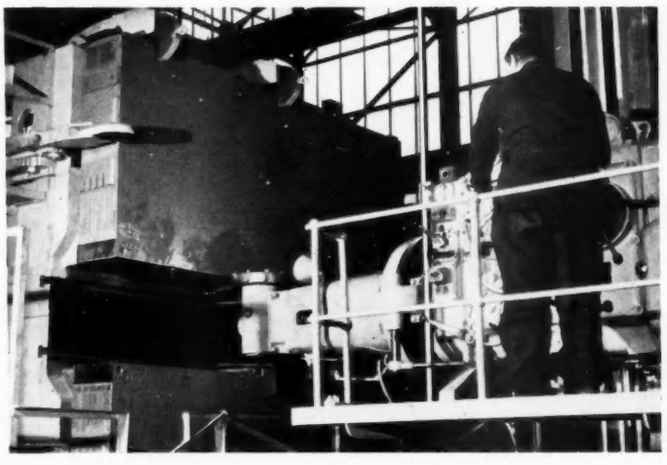
No burrs are permitted between laminations, as they would cause electrical short-circuiting. To achieve the limits specified, the sector must be at a constant temperature throughout its mass to within 0·75° C, and the minimum of clamping must be used, to prevent distortion. For the final machining of the active face, there is hardly any clamping at all. For all machining operations (except the 2½ in by 1½ in slot) 14 in diameter face cutters are used, with tungsten carbide blade. Ten negative rake blades are used for rough machining the throat and for the ½ degree taper on the back of the sector. Final machining is done with seven positive rake blades. A freshly ground cutter is used for each sector, to ensure freedom from burrs.

FINISHING

After the sector has been completely machined, the coil bracket assemblies are jigged in position and sequence welded in place. The sector then stands for at least 12 hours to allow the heat of welding to dissipate. After this period it is given a final coat of paint.

For final inspection each sector is set up with the mean plane of the bottom throat face horizontal to within 20 sec of arc, the back taper faces being not more than 0·030 in out of vertical, measured over the height of the sector.

Twelve readings are taken between the jaws of the throat on the 23 in $\pm$ 0·005 in dimension, after clinometer readings for flatness of 0·004 in have been established. Three thermometer readings are taken at the back of the throat and six at the back of the sector; the difference between individual readings in any group must not exceed 0·75° C.



The sectors are machined in the throat on a horizontal boring and milling machine, which is also used to put the taper on the backs.

Marketing

Five Year Trade Plan

The five-year Anglo-Soviet trade agreement signed in Moscow last week should lead to what Sir David Eccles, the president of the Board of Trade, called " a substantial increase of trade on both sides, starting in the first year." He expects British imports from Russia to rise from about £57 million last year to £80 million this year. Russian purchases of British goods are also likely to increase substantially. For the first time in any trade agreement between the two countries consumer goods are included: about £2 million a year each way. Quotas will be fixed in talks with a Soviet mission which will come to London in about five weeks' time. Russia will buy British motor vehicles, clothing, textiles, footwear, sporting goods and floor coverings, and will get quotas for the sale of Soviet cars, toys, musical instruments, watches, wines and brandy in this country.

The basic Russian interest remains in capital goods. Further large orders are expected to be placed shortly, with the main emphasis on chemical and food-processing plants. Although Russia is not likely to export enough to Britain to pay for her imports, it is possible that they will receive a substantial quota for machinery. Sir David Eccles told the Soviet representatives that it may be some time before their machines can be sold in any quantities. Obviously, a sales force, backed by advertising and the necessary service facilities, will have to be established. The Russians will doubtless work through British agents but it will take time to secure a foothold in what has become a highly competitive market.

Plea to Buy Russian

A penetrating and immensely frank analysis of the main factors affecting Anglo-Russian trade was made by Mr. S. F. Anfimov, the deputy trade representative of the USSR in the United Kingdom, at the 43rd Annual General Meeting of the Russo-British Chamber of Commerce. Mr. Anfimov had just been elected a vice-president of the Chamber.

The main tenet of Mr. Anfimov's speech is that Britain can expect to export to Russia only in the measure in which she imports Russian goods. He emphasised that Russia was not angling for credit and that the fulfilment of their Seven-Year Plan depended on their own efforts and on their own internal resources. He quoted Mr. Khrushchev, however, on the policy of his Government in relation to a large expansion of Russian imports: " If any States or firms are interested in getting new and large orders from us, in order to book up their industry and provide employment for workers, we can place these orders, provided credits are extended to us." The main obstacle to a substantial increase in Soviet imports was that " the rate of purchases of Soviet goods by British firms is not nearly great enough." Mr. Anfimov invited inquiries for industrial equipment, pointing out that last year the Soviet Union exported £270 million worth of capital goods to European countries.

At the present time, said Mr. Anfimov, negotiations are going on with British firms about the purchase of six plants to the total value of about £50 million. More British imports, and the removal of strategic embargoes were the two main obstacles to increased Soviet purchases of British engineering products.

Pye in The Soviet Sky

Pye's sweet revenge for the punishment handed to them by the United States Foreign Commerce Department continues at a merry pace. Almost immediately following his return from his visit to this country Marshall Zhigarev, chief of Aeroflot, the Soviet State airline, placed a contract worth about £100,000 for two Pye

aircraft landing systems for installation at Moscow airport. This system, which is internationally approved, uses electronically stabilised beams to give the pilot an instrument display in the cockpit, thus obviating the language difficulties encountered in talk-down systems.

When they announced the Russian contract recently, Pye said that eight of their landing systems had been ordered in one week and that orders "were coming in from all over the world."

Look to Scandinavia

An unusual approach to cooperative trading was made recently by eight Scandinavian businessmen who spent a week in London "to tell British firms just how to sell more goods to Norway, weden, Denmark and Finland—an area which even now buys two thousand million pounds worth of foreign products every year."

These men were the representatives of the Scan Group, which is described as "a cooperative organisation." They were in fact acting for advertising interests in their own countries and offering their knowledge of the requirements of the Scandinavian markets as well as facilities for carrying out advertising and public relations on the spot. The fact that British exports account for only about one-seventh of total Scandinavian imports (£278 million last year out of a total bill of over £2,000 million) suggests that there is plenty of room for expanding sales.

Firm Face

How a large company appears to the public can vitally affect growth and development. Workers have to be attracted, particularly young people finishing their education; investors have to be persuaded to lend their savings; customers, suppliers and the firm's own workers (in this case in many different plants in several countries) all have to be told what the firm is doing and how it is progressing. Film is proving increasingly effective in putting the whole firm across.

Associated Electrical Industries have produced two films recently. One of them, "Another Name for Power," shows the progress of Britain's electricity generating industry and the part played by AEI in expansion. The film has been produced "as a convenient way of taking stockholders around" the factories of the group. It shows work in progress in many of the 50 AEI factories and illustrates the wide diversity of manufacturing interests. For instance, telecommunication equipment is shown being assembled and tested at Woolwich; cathode ray tubes being mass produced at Sunderland; motors being assembled at Birmingham and fluorescent lamps being inspected at Leicester. The erection of a boiler at the Berkeley Power Station emphasises nuclear activities.

The other film, "On Course with AEI," follows the careers of three boys training to become professional engineers at the company's training centres in Manchester, Rugby and London. It shows the apprentice school at Manchester, where the students begin their training, and shows them gaining practical experience on the shop floor and also at work in a nearby technical college. It closes on an encouraging note: five of the Board of British Thomson-Houston are ex apprentices, as are all nine of the board of Metropolitan-Vickers. This really is "room as the top."

At Home

EUROVISION ANNIVERSARY LINKS

Saturday, 6 June, marks the fifth anniversary of the first European exchange of television programmes. To celebrate the occasion 12 countries will be joining in a 75 minute entertainment to be relayed over 14 networks. An untold number will be watching "The World Outside"—there are over 10 million sets in Britain alone.

The first tentative step was the broadcasting of a fête at Calais in 1950. Many of the later problems did not then arise as BBC equipment was used at both ends of the link. In 1952 18 programmes were relayed to both Britain and France during the Anglo-French week. 1953 "saw" the Coronation, which probably did more to make the Continent television conscious than any other single event. It was relayed to France, Belgium, Holland and Germany. In the first programme exchange in 1954, Britain France, Belgium, Holland, Denmark, Germany, Switzerland and Italy took part. For the anniversary event, Sweden, Luxembourg, Monaco and Austria have joined in.

The linking up of nations for this sort of television programme involves two major problems: the transmission across comparatively large distances, and the conversion of the video signals to the standards used in each country.

Problems of transmission over long distances has been met by the use of microwave radio links with relay stations, as at these frequencies transmission is virtually limited to line of sight—and Europe is not flat. In a few cases, as in Britain, underground coaxial cables have been used. Conversion from one standard to another, however, is quite a different matter.

The solution that has been used successfully for some time, and which will be employed on 6 June, is on the face of it a simple one: take for example a broadcast from Britain (405 lines) to France (819 lines). At some point, in this particular instance in Paris, the signal on 405 lines is fed to a receiver giving a normal picture. This is viewed by a camera working at 819 lines and transmitted over the French network in the usual way. Apparently perfectly simple, with perhaps a slight loss of definition. However, there are three main snags to be overcome.

The first is that the image appearing on the cathode ray tube is not a solid picture but actually a flying spot of light which can cause an unconverted component of the input signal to appear in the convertor output; the second is that "line beating" can occur as the result of the strobing patterns produced when the scanning beam of the camera tube explores the line structure of the image; the third is that any difference in frame frequency between the two standards will result in a cyclic variation of the vertical distance, on the target of the camera tube, separating the image of the cathode-ray-tube spot and the camera scanning beam. All three have, however, been largely overcome as the excellence of the final pictures shows.

For a concrete example take a recent broadcast from Wimbledon to France, Belgium, Holland, Denmark, Germany, Switzerland and Italy. The 405 line signal from London was relayed by land line to Swingate (near Dover) and then by microwave links to Lille. Here it was divided, one portion going to Paris for conversion to 819 lines and diffusion over the French networks, and one to Brussels where it was again split and relayed to Bussum (in Holland) and Cologne. At the former it was converted to 625 lines and fed to the networks

General view of a relay from Paris.

in Holland and Belgium, and at Cologne it was converted, also to 625 lines, and fed direct to the German network, as well as being relayed to Copenhagen for diffusion in Denmark, Vetliberg for the Swiss system and to Milan for Italy, all of which operate on the 625 lines. A similar procedure will be followed in the anniversary broadcast.

But vision without sound is only half the cake, and sound, though it avoids the problem of standards conversion, introduces one peculiarly its own—language. For the actual coverage of the distances involved there are in existance normal international radio circuits and land lines (telephones) that can be used, though here again cooperation of the highest order is required; a careless operator at any one of the many telephone exchanges that are links in the chain has only to pull out a wrong plug to sever communication completely, and the task of locating the break could be very time consuming.

The language problem is overcome as a rule by having a commentator for each system who watches the broadcast on a monitoring tube and speaks to his own country. To his comments are added what can be described as "crowd noises" for want of a better term. At some centre in each country, commentary and noises are mixed and diffused with the video signal over the internal network.

And that, very briefly is what lies behind the Eurovision exchange programmes, as organised by the European Broadcasting Union. Their success is the result of international technical skill and first class team work.

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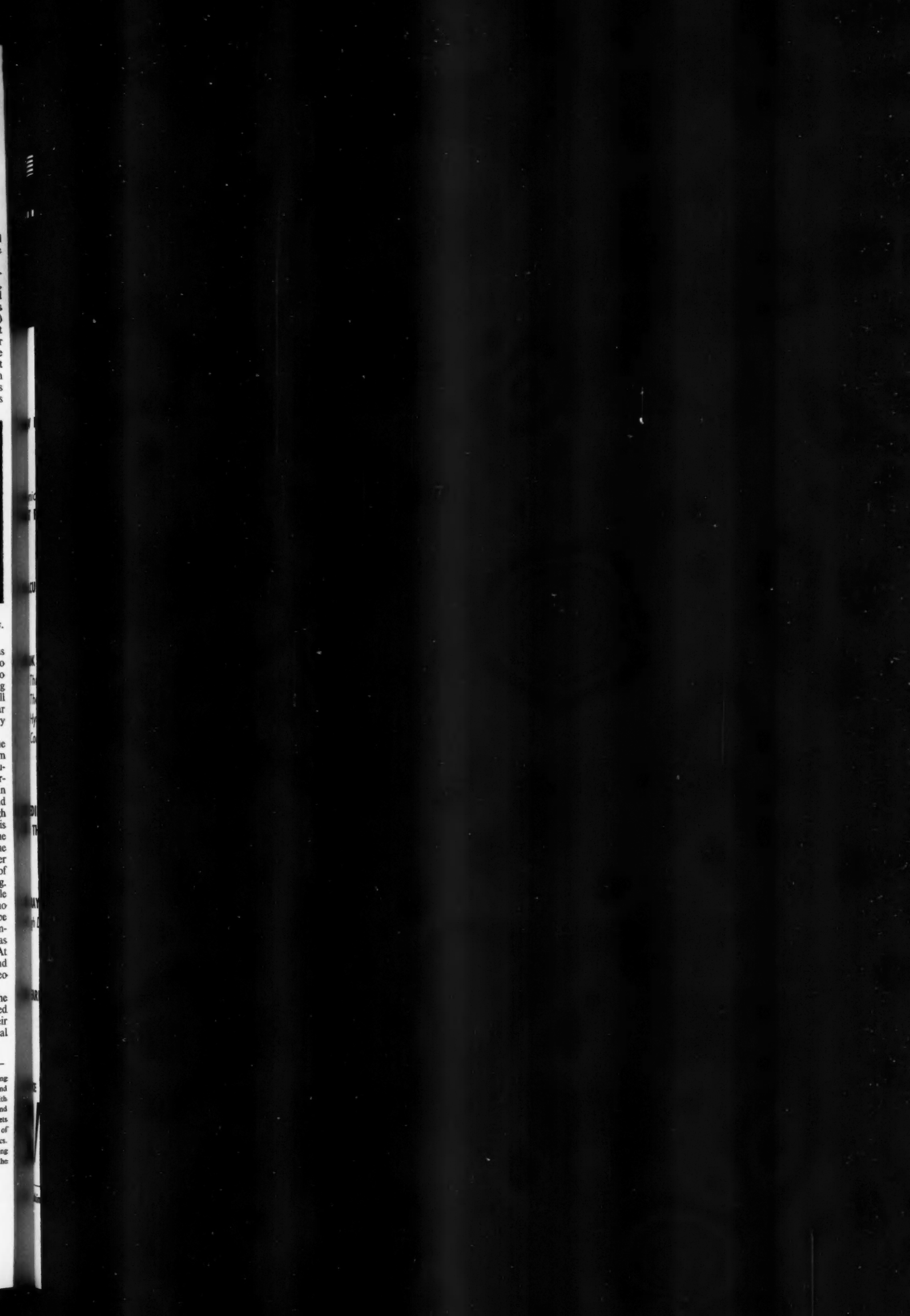
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